PB82-111618

Impact of Canadian Power Plant Development and Flow Apportionment on the Poplar River Basin

Tetra Tech, Inc.
Lafayette, CA

Prepared for

Environmental Protection Agency
Helena, MT

Jun 81

U.S. Department of Commerce
National Technical Information Service
NTIS

PB82-111618

EPA

United States
Environmental Protection
Agency

Montana Office EPA
Region 8
Federal Building
Helena, Montana 59601

EPA 908/5-81-003
JUNE, 1981

FINAL ENVIRONMENTAL IMPACT STATEMENT

Impact of Canadian Power Plant Development and Flow Apportionment on the Poplar River Basin

Prepared with the assistance of Tetra Tech Inc.

REPRODUCED BY
NATIONAL TECHNICAL
INFORMATION SERVICE
U.S. DEPARTMENT OF COMMERCE
SPRINGFIELD, VA 22161

EPA 908/5-81-003

JUNE 1981

FINAL ENVIRONMENTAL IMPACT STATEMENT

IMPACT OF CANADIAN POWER PLANT DEVELOPMENT AND FLOW APPORTIONMENT ON THE POPLAR RIVER BASIN

U.S. Environmental Protection Agency
Montana Office Region 8
Helena, Montana

Prepared with assistance of Tetra Tech staff
Tetra Tech, Incorporated
3746 Mt. Diablo Boulevard, Suite 300
Lafayette, California 94549
(415) 283-3771
EPA Contract No. 68-01-4873
Tetra Tech Report No. TC-3254

EPA 908/5-81-003

JUNE 1981

FINAL ENVIRONMENTAL IMPACT STATEMENT

IMPACT OF CANADIAN POWER PLANT DEVELOPMENT AND FLOW APPORTIONMENT ON THE POPLAR RIVER BASIN

Responsible Agency
U. S. Environmental Protection Agency
Montana Office Region 8
Helena, Montana
In cooperation with the U. S. Department of State

ABSTRACT

A 300 megawatt coal-fired power plant has been constructed by Saskatchewan Power Corporation on the East Fork of the Poplar River about 4 miles north of the International Boundary, another 300 megawatt unit is under construction. The power plant and associated reservoir will result in a water use and will modify the transboundary flow of the Poplar River. A flow apportionment agreement between the U. S. and Canada will be established. This EIS addresses the impacts of several flow apportionment alternatives in addition to other potential impacts of the power plant on the U. S. part of the Poplar River Basin. The Poplar River flows will be reduced under conditions of the recommended apportionment. These reduced flows result in less water available for irrigation expansion. Lower flows may also impact furbearers, waterfowl, fish and other organisms. Water quality will be degraded with total disolved solids levels increasing. The highest concentrations of airborne pollutants will occur in the U. S. southeast of the power plant. The predicted concentrations were less than the U. S. National Ambient Air Quality Standards and the Montana Ambient Air Quality Standards for 1-hour, 3-hour, 24-hours, and the annual mean. Fumigation under very stable conditions could result in elevated SO_2 concentrations. The impact of fumigation events would be minimal because of the small area affected by one event, the short time period, and the low frequency of occurrence. The SO_2 concentrations predicted by the EIS with two 300 MWe units and no SO_2 control would exceed Class I PSD regulations at Fort Peck Indian Reservation (not presently desginated), but not at the Medicine Lake National Wildlife Area. Comparison of the predicted concentrations of SO_2, NO_x and particulates with acute and chronic threshold limits for selected plant species indicated no detectable impacts on the terrestrial vegetation. No impacts were predicted due to accumulation of trace metals in soils.

COMMENTS MUST BE RECEIVED BY:

Please send comments and inquiries to: Gene Taylor, Montana Office, EPA, Federal Building, Drawer 10096, 301 South Park, Helena, Montana 59626, (406) 449-5486.

Approved by: ______________________
Roger L. Williams
Regional Administrator

Date: ______________________

Copies of the Final Environmental Impact Statement will be sent to the following:

International

- International Joint Commission
- International Poplar River Water Quality Board

Canada

- Province of Saskatchewan
- Saskatchewan Power Corporation

Congressional

- U. S. Senator John Melcher
- U. S. Senator Max Baucus
- U. S. Representative Ron Marlene

Montana

- Governor of Montana
- Lt. Governor of Montana

- Department of Agriculture
  - Cooperative Extension Service
- Department of Community Affairs
- Department of Health and Environmental Sciences
- Department of Fish, Game and Parks
- Department of Natural Resources and Conservation
- Environmental Quality Council
- Historical Society
- Old West Regional Commission

Federal

- U. S. Department of State

- Advisory Council on Historic Preservation
- Army Corps of Engineers
- Department of Agriculture
  - Soil Conservation Service
- Department of Commerce
- Department of the Interior
  - Bureau of Indian Affairs
  - Bureau of Land Management
  - Bureau of Mines
  - Bureau of Outdoor Recreation
  - Bureau of Reclamation
  - Fish and Wildlife Service
  - Geological Survey
  - Heritage Conservation and Recreation Service

Federal (Continued)

- Missouri River Basin Commission
- National Park Service
- Department of Housing and Urban Development
- Department of Health Education and Welfare

Local Government

- Sheridan County Commissioners
- Daniels County Commission
- Roosevelt County Commission
- Town of Scobey
- Town of Plentywood
- Town of Wolf Point
- Town of Poplar

Other Organizations and Individuals

- Fort Peck Indian Reservation
- Norther Plains Resource Council
- Three Corners Boundary Association
- Environmental Information Center
- Montana Wildlife Federation
- National Wildlife Federation
- Friends of the Earth
- Trout Unlimited
- Ducks Unlimited
- Daniels County WIFE - Zelpha Danielson - Scobey
- Dale Chabot - Scobey
- Lowell Burgett - Scobey
- Jim Simms - Soil Science Lab, MSU, Bozeman
- Delmer Safty - Whitetail
- Dr. Merele D. Fitz - Scobey
- Tittinger Brothers - Scobey
- Environmental Studies Lab., U. of M. - Missoula
- Glasgow Public Library
- Plentywood Public Library
- Scobey Public Library
- Wolf Point Public Library
- Hugh Baker - Whitetail
- Dr. Robert R. Bell, DVM, Culbertson
- Charles Cassidy - Scobey
- Bill Cromwell - Flaxville
- Ken Lee - DVM, Scobey
- Farver Brothers - Scobey
- Lyle Hang - Scobey
- Hellickson Brothers, Inc. - Scobey
- Gordon Holte - Plentywood

Other Organizations and Individuals (Continued)

Lee Humbert - Scobey
Art Lund - Scobey
Dennis Nathe - Redstone
Lee Rovig - Outlook
Robert Schneekloth - Redstone
Ted Skornogoski - Scobey
Ron Stoneberg - Circle
Bill Tande - Scobey
Boyd Tymofichuk - Scobey
Eddie Lund - Scobey
Daniels County Leader - Scobey
Plentywood Herald
Glasgow Courier
Wotanian - Poplar
Wolf Point Herald

TABLE OF CONTENTS

Page

1. Summary 1
    1.1 Background 1
    1.2 Water Quality Impacts 2
        1.2.1 Flow Apportionment Alternatives 2
        1.2.2 Impacts on Beneficial Uses of Flow Apportionment 3
            1.2.2.1 Municipal Water Supply 6
            1.2.2.2 Stock and Spreader Irrigation 6
            1.2.2.3 Summer Irrigation 9
            1.2.2.4 Winter Flows 11
            1.2.2.5 Flow Impacts on Biota 11
        1.2.3 Impacts on Ground Water 12
    1.3 Water Quality Impacts 13
        1.3.1 Total Dissolved Solids 13
        1.3.2 Sulfate 14
        1.3.3 Boron 15
        1.3.4 Sodium Adsorption Ratio 15
        1.3.5 Combined Water Quality Impacts on Crops 15
        1.3.6 Water Quality Impacts on Fishes 17
    1.4 Air Quality Impacts 17
        1.4.1 Ambient Quality 17
        1.4.2 Fumigation 22
        1.4.3 Trace Element Deposition 24
        1.4.4 Acidification of Soils 24
        1.4.5 Other Air Quality Impacts 25
    1.5 Socioeconomic Impacts 25
        1.5.1 Socioeconomic Setting 25
        1.5.2 Impact of Flow Apportionment 26
        1.5.3 Other Impacts 28

2. Purpose and Need 29

3. Alternatives Including the Proposed Action 36
    3.1 Atmospheric Emissions and Control 36
    3.2 Flow Related Alternatives 43
        3.2.1 Alternative Flow Apportionments 43
        3.2.2 No Action Case 44
        3.2.3 Demand Releases 46
    3.3 Water Quality 47
        3.3.1 Mitigation of Water Quality Impacts 49

4. Affected Environment 51
    4.1 Location 51
    4.2 Geology and Soils 52

TABLE OF CONTENTS (continued)

Page

4. Affected Environment (continued)
  4.3 Land Use 55
    4.3.1 General 55
    4.3.2 Land Use Surveys 57
    4.3.3 Agricultural Activities 57
  4.4 Hydrology 60
    4.4.1 Surface Water 60
    4.4.2 Ground Water 64
  4.5 Water Quality 69
    4.5.1 Surface Water 69
    4.5.2 Ground Water Quality 76
  4.6 Water Use 80
    4.6.1 Municipal Use 80
    4.6.2 Industrial Use 80
    4.6.3 Agricultural Use 80
      4.6.3.1 Montana Water Use 80
      4.6.3.2 Water Use on the Fort Peck Indian Reservation 81
      4.6.3.3 Canadian Water Use 84
  4.7 Vegetation and Wildlife 84
  4.8 Aquatic Biota and Fisheries 86
  4.9 Meteorology and Air Quality 87
    4.9.1 Meteorology 87
    4.9.2 Existing Air Quality 89
  4.10 Social and Economic Profiles 89
    4.10.1 Population Profile 89
    4.10.2 Archaeological and Historical Sites 91
    4.10.3 Economic Profile 91

5. Environmental Consequences 93
  5.1 Air Quality Impacts 93
    5.1.1 Air Quality Model 93
    5.1.2 Power Plant Emissions 93
    5.1.3 Model Input Parameters 94
    5.1.4 Modeling Results 94
      5.1.4.1 Sulfur Dioxide (SO_2) 94
      5.1.4.2 Oxides of Nitrogen (NO_x) 95
      5.1.4.3 Particulates 102
      5.1.4.4 Comparison of Model Outputs for the Years 1964 and 1960 102
    5.1.5 Impact Assessment 102
      5.1.5.1 Sulfur Dioxide Impact 106
      5.1.5.2 NO_x Impact 107
      5.1.5.3 Particulate Impact 108
      5.1.5.4 Fumigation Impact 111
      5.1.5.5 Visibility Impacts 119
      5.1.5.6 Health Effects 119

TABLE OF CONTENTS (continued)

Page

5. Environmental Consequences (continued)

5.2 Water Quality Impacts 121
5.2.1 Methodology 121
5.2.1.1 Flow Scenarios 121
5.2.1.2 Model Description 121
5.2.1.3 Water Uses 125
5.2.2 Predicted Flows 137
5.2.2.1 High Flow Conditions 137
5.2.2.2 Low Flow Conditions 145
5.2.3 Direct Impacts 149
5.2.3.1 Municipal Water Supply 149
5.2.3.2 Uses Dependent on Spring Runoff 150
5.2.3.3 Summer Flows 151
5.2.3.4 Winter Flows 153
5.2.4 Impacts on Groundwater Levels 154
5.3 Water Quality Impacts 155
5.3.1 Description of Quality Models 155
5.3.2 Boron 156
5.3.2.1 Boron Impacts on Crops 157
5.3.2.2 Other Boron Impacts 163
5.3.3 Salinity and Sodicity 163
5.3.3.1 Salinity and Sodicity Impacts on Crops 164
5.3.3.2 Impact on Crops of Combined Effects of Salinity, Sodicity, and Boron . . . 170
5.3.3.3 Other Salinity Impacts 171
5.3.4 Sulfate (SO_4) 172
5.3.5 Mitigative Measures to Reduce Impacts of Saline Irrigation Waters 173
5.3.5.1 Mitigative Practices for Salinity Control in Soils 173
5.3.5.2 Mitigative Irrigation Practices for Salinity Control in Return Flows . . . 174
5.3.5.3 Source Control of Salinity 177
5.4 Socioeconomic Impacts of Power Plant Construction . . . 179
5.4.1 Introduction 179
5.4.2 Description of the Construction Work Force . . . 179
5.4.3 Economic Impacts from the Plant 181
5.4.4 Economic Impacts from the Construction Workers 181
5.4.5 Secondary Impacts 183
5.5 Socioeconomic Impacts of Apportionment 186
5.5.1 Introduction 186
5.5.2 Future Conditions 186
5.5.3 Impacts on Income 188
5.5.4 Other Impacts 194
5.5.4.1 Impacts on Investment in Land and Equipment 194

TABLE OF CONTENTS (continued)

Page

5. Environmental Consequences (continued)
- 5.5.4.2 Impacts on Assessed Values and Tax Revenues 194
- 5.5.4.3 Impacts on Population and Employment 195
- 5.5.4.4 Impacts on Grazing Land 195
- 5.5.4.5 Impacts on Riparian Lands 196
- 5.6 Biological Impacts 197
  - 5.6.1 Impacts of Atmospheric Emissions on Terrestrial Biota 197
    - 5.6.1.1 Effects on Vegetation and Crops 197
    - 5.6.1.2 Potential for Acidification of Soils . 202
    - 5.6.1.3 Effects of Fumigation 204
    - 5.6.1.4 Effect of Particulate Emissions 206
  - 5.6.2 Impacts of Atmospheric Emissions on Aquatic Biota 210
    - 5.6.2.1 Acidification and Nitrogen Loading . . 210
    - 5.6.2.2 Trace Element Contamination 210
  - 5.6.3 Impacts of Water Quality Changes on Fish and Wildlife 214
    - 5.6.3.1 Effects of Thermal Discharges 214
    - 5.6.3.2 Effects of Dissolved Solids Increases 218
    - 5.6.3.3 Effects of Dissolved Oxygen Changes . . 219
    - 5.6.3.4 Bioaccumulation of Metals 221
    - 5.6.3.5 Other Constituents 223
  - 5.6.4 Impacts of Flow Modifications on Fish and Wildlife 223
    - 5.6.4.1 Wildlife and Furbearers 223
    - 5.6.4.2 Fish 224

6. References 243

7. Public Comments 258

8. List of Preparers 373

LIST OF FIGURES

Figure		Page
1.2.1	Location of Stations Used in Flow Model	8
2.1-1	Location of the Poplar River Basin	30
2.1-2	Location of Poplar River Power Plant Site	31
4.2-1	Quaternary Geology of the U.S. Part of the Poplar River Basin	53
4.3-1	Land Use in Area 1 Surveyed by Duggan (1978)	58
4.3-2	Land Use in Area 2 Surveyed by Duggan (1978)	59
4.4-1	Major Sub-Basins of the Poplar River System	63
4.4-2	Outflow Hydrograph for the Poplar River Near Poplar, Montana, October 1975 to September 1976	66
4.4-3	Schematic of Typical Reach of the Poplar River	67
4.4-4	Groundwater Flow Regime in Canadian Part of Poplar River Basin	68
4.4-5	General Ground Water Flow Regime in U.S. Part of Poplar River Basin	70
4.5-1	Location of Water Quality Sampling Stations	71
4.5-2	Ranges of Selected Chemical Parameters in Water Samples from the Fort Union Formation and Fox Hills-Hell Creek Formation in the U.S. Part of the Poplar River Basin	77
4.5-3	Ranges of Selected Chemical Parameters in Water Samples from Quaternary Alluvium, Glacial Outwash and Flaxville Formation in the U.S. Part of the Poplar River Basin	78
4.6-1	Historical Water Use in the U.S. Part of the Poplar River Basin 1955 through 1974	82
4.6-2	Historical Water Uses on the Fort Peck Indian Reservation 1955 through 1975	83
4.9-1	Normal Monthly Precipitation at Scobey, Montana . . .	88
4.10-1	Location of Historic Sites in the Poplar River Basin and Adjacent Areas	92
5.1-1	Spatial Distribution of the Highest 1-hour SO_2 Concentrations ($\mu g/m^3$) Obtained from the CRSTER Model for 1964, Assuming a 600 MW (1200 MW) Poplar River Power Plant with Zero Percent Emission Control .	96
5.1-2	Spatial Distribution of the Highest 3-hour SO_2 Concentrations ($\mu g/m^3$) Obtained from the CRSTER Model for 1964, Assuming a 600 MW (1200 MW) Poplar River Power Plant with Zero Percent Emission Control .	97
5.1-3	Spatial Distribution of the Highest 24-hour SO_2 Concentrations ($\mu g/m^3$) Obtained from the CRSTER Model for 1964, Assuming a 600 MW (1200 MW) Poplar River Power Plant with Zero Percent Emission Control .	98
5.1-4	Spatial Distribution of the 1964 Annual SO_2 Concentrations ($\mu g/m^3$) Obtained from the CRSTER Model, Assuming a 600 MW (1200 MW) Poplar River Power Plant with Zero Percent Emission Control	99

LIST OF FIGURES (continued)

Figure		Page
5.1-5	Spatial Distribution of the Highest 1-hour NO_x Concentrations ($\mu g/m^3$) Obtained from the CRSTER Model for 1964, Assuming a 600 MW (1200 MW) Poplar River Power Plant	100
5.1-6	Spatial Distribution of the 1964 Annual NO_x Concentrations ($\mu g/m^3$) Obtained from the CRSTER Model, Assuming a 600 MW (1200 MW) Poplar River Power Plant	101
5.1-7	Spatial Distribution of the Highest 24-hour Particulate Concentrations ($\mu g/m^3$) Obtained from the CRSTER Model for 1964, Assuming a 600 MW (1200 MW) Poplar River Power Plant with 99.5 Percent Emission Control	103
5.1-8	Spatial Distribution of the 1964 Annual Particulate Concentrations ($\mu g/m^3$) Obtained from the CRSTER Model, Assuming a 600 MW (1200 MW) Poplar River Power Plant with 99.5 Percent Emission Control	104
5.1-9	Schematic of Low-Level Inversion Breakup Resulting in Fumigation	112
5.2-1	Location of Stations with Flow Results	122
5.2-2	Projected Canadian Water Uses on the East Fork	126
5.2-3	Projected Canadian Water Uses on the Middle Fork . . .	127
5.2-4	Projected Canadian Water Uses on the West Fork and Tributaries	128
5.2-5	Projected U.S. Water Uses on the East Fork of the Poplar River	131
5.2-6	Projected U.S. Water Uses on the Middle Fork of the Poplar River Above the Confluence with the East Fork	132
5.2-7	Projected U.S. Water Uses on West Fork of the Poplar River (Includes Indian and Non-Indian Uses)	133
5.2-8	Projected U.S. Water Uses on Main Stem of Poplar River Above Fort Peck Indian Reservation and Below Confluence of Middle and East Forks	134
5.2-9	Projected U.S. Water Uses on Main Stem of Poplar River Within Fort Peck Indian Reservation	135
5.2-10	Predicted High Flows at East Fork of Poplar River at International Border	138
5.2-11	Predicted High Flows at East Fork of Poplar River at Scobey	140
5.2-12	Predicted High Flows at Middle Fork of Poplar River at International Border	141
5.2-13	Predicted High Flows of Main Poplar River at Fork Peck Indian Reservation	142
5.2-14	Predicted High Flows of West Poplar at the International Border	143

LIST OF FIGURES (continued)

Figure		Page
5.2-15	Predicted High Flows of Poplar River at Poplar	144
5.2-16	Predicted Low Flows at East Fork at International Border	146
5.2-17	Predicted March Flows on the East Fork 1933-1974 . . .	147
5.2-18	Predicted April Flows on the East Fork 1933-1974 . . .	148
5.3-1	Boron Concentrations in July on East Fork and Main Stem of Poplar River for Scenarios 28, 29, 31, and 32	158
5.3-2	Boron Concentrations in July on East Fork and Main Stem of Poplar River for Scenarios 4A and 8A	159
5.4-1	Estimated Construction Work Force Profile, Saskatchewan Power Plant Unit 1, 1975 through 1980 . .	180
5.6-1	Dose-Injury Curves for (a) SO_2-Sensitive Plant Species, (b) Plant Species of Intermediate SO_2 Sensitivity, and (c) SO_2-Resistant Plant Species . . .	200
5.6-2	River Heat Release Summary	216
5.6-3	Sediment Flux Versus Flow at the International Boundary East Fork Poplar River	230
5.6-4	Relationship Between Flow and Year-Class Formation of Game Fish in the East and Middle Forks of the Poplar River	236

LIST OF TABLES

Table		Page
1.2-1	Descriptions of Apportionment Alternatives	4
1.2-2	Reservoir Releases on the East Fork of the Poplar River	5
1.2-3	Summary of Flow Scenarios	7
1.4-1	Comparison of Emission Rates from Selected Power Plants	18
1.4-2	Estimated Maximum Pollutant Concentrations in Montana from the Poplar River Power Plant	20
1.4-3	Predicted Maximum SO_2 Concentrations at the Fort Peck Indian Reservation Boundary	21
1.4-4	Comparison of Calculated SO_2 Due to Fumigation, for 600 MW Plant	23
1.5-1	Impacts of Apportionment and Water Quality on Personal Income in Daniels and Roosevelt Counties . . .	27
3.1-1	Estimated Maximum Pollutant Concentrations in Montana from the Poplar River Power Plant	37
3.1-2	Maximum SO_2 Concentrations in the U.S. Expressed as a Percentage of the Maximum Allowable Increase (PSD) in Class II Areas	38
3.1-3	Predicted Maximum Particulate Concentration at the Fort Peck Indian Reservation Boundary	40
3.1-4	Predicted Maximum SO_2 Concentrations at the Fort Peck Indian Reservation Boundary	42
3.2-1	June Flows Under Alternative Apportionments	45
3.3-1	Range of Predicted Water Quality for Alternative Apportionments for March through September	48
4.3-1	Land Use Characteristics of 1974 Daniels and Roosevelt Counties Expressed in Acres and as the Percent of the Total Area	56
4.3-2	Livestock Inventory for Daniels County	61
4.3-3	Acres in Irrigated and Non-Irrigated Crops Daniels County, 1975	61
4.3-4	Crop Production, Roosevelt County, 1975	62
4.3-5	Livestock Inventory, Roosevelt County	62
4.4-1	Perennial Stream Length and Drainage Basin Areas for the Poplar River Basin	65
4.4-2	Comparison of Expected Annual Flows, Mean Flows and the 1975 Flows in the Poplar River	65
4.5-1	Recent Water Quality Data for East, Middle, and West Forks of the Poplar River at the International Boundary	74
4.5-2	U.S. EPA Water Quality Criteria Contraventions on the Poplar River, 1975	75
4.6-1	Estimates of Existing Water use for Gravity/Pump Irrigation in the U.S. Poplar River Basin	85

LIST OF TABLES (continued)

Table Page

4.10-1 Population in Daniels and Roosevelt Counties, 1970-1975, and Percentage Change, 1970-1975 90
5.1-1 Estimated Maximum Pollutant Concentrations in Montana from the Poplar River Power Plant 105
5.1-2 Calculated Increases in Air Concentrations of Trace Elements near the Poplar River Plant 109
5.1-3 1975 Background Trace Element Concentrations ($\mu g/m^3$) Measured near Glasgow, Montana 110
5.1-4 Estimates of Maximum Ground-Level Concentrations ($\mu g/m^3$) During Morning Fumigation 113
5.1-5 Estimates of Maximum Ground-Level Concentrations ($\mu g/m^3$) During Morning Fumigation Resulting from Typical Meteorological Conditions at Scobey, Montana 114
5.1-6 Estimates of Maximum Ground-Level NO_x Concentrations ($\mu g/m^3$) During Morning Fumigation Resulting from Typical Meteorological Conditions at Scobey, Montana 115
5.1-7 Estimates of Maximum Ground-Level Total Suspended Particulate (TSP) Concentrations ($\mu g/m^3$) During Morning Fumigation Resulting from Typical Meteorological Conditions at Scobey, Montana 116
5.1-8 Average Meteorological Conditions (100-200 m Layer) and Plume Heights During the Morning for the Mid-Seasonal Months at Scobey, Montana 117
5.1-9 Expected Health Effects of Air Pollution on Selected Population Groups 120
5.2-1 Reservoir Releases on the East Fork of the Poplar River 123
5.2-2 Summary of Flow Scenarios 124
5.3-1 Irrigation Requirements and Dilution Factors for Alfalfa and Small Grains 162
5.3-2 Salinity, SAR, and SO_4 Concentrations at Selected Stations 165
5.3-3 Available Studies on Salinity and Sodicity Hazards . . 167
5.3-4 Average Chemical Data for Upper Basin Soils and Soils Within Ft. Peck 169
5.3-5 Relative Tolerances of Various Crops and Forage Species to Salinity Arranged According to Decreasing Tolerances Within Groups 175
5.4-1 Total Personal Farm and Nonfarm Income Daniels and Roosevelt Counties 1972-1977 182
5.4-2 Total Retail Sales Daniels and Roosevelt Counties 1973-1977 184

LIST OF TABLES (continued)

Table		Page
5.5-1	Projected Population and Employment Daniels and Roosevelt Counties--1980, 1985 and 2000	187
5.5-3	Change in Yield and Per-Acre Revenues for Wheat	190
5.5-2	Change in Net Farm Income Resulting from Apportionment Only	191
5.5-5	Estimated Impacts on Net Farm Income from Loss of all Irrigated Acreage	193
5.6-1	Reported Threshold Limits of Important Native Plant and Cultivated Species Found in the Impact Area to Gaseous SO_2, NO_x and $SO_2 + NO_x$ Emission Exposures . . .	198
5.6-2	Projected Deposition Rates, Soil Concentrations and Plant Accumulation of 17 Trace Elements Resulting from Particulate Emissions	208
5.6-3	Minimum and Maximum Concentration of Trace Elements in Poplar River Basin Vegetation (μg/g) Samples Collected During the Late Summer of 1977	209
5.6-4	Trace Element Concentrations (PPM) in Poplar River Coal Ash Samples	212
5.6-5	Average Trace Element Concentrations (μg/ℓ) in the Poplar River and Projected Increases due to Atmospheric Emissions of the Poplar River Power Plant	213
5.6-6	Mercury Content of Fish Muscle Tissue from the Poplar River	222
5.6-7	Bed Material Size Distribution	227
5.6-8	Comparison of 1977-1979 Spring Flows at Selected Poplar River Stations	233
5.6-9	Predicted Average April Flows (cfs) in the East Fork Poplar River	234
5.6-10	Predicted Relative Impact of Flow Apportionment on Young-of-the-Year Class Strength of Poplar River Game Fish	238
5.6-11	Recommended Instream Flows for the East Fork of the Poplar River	241

1. Summary

1.1 Background

In 1972, Saskatchewan Power Corporation (SPC) submitted an application for water rights on the Poplar River, a river which crosses the International Boundary in eastern Montana. The purpose of this application was to obtain condenser cooling water for a coal-fired power plant. The generating complex includes a newly-created reservoir on the East Fork to be used as a once-through cooling water source, a lignite coal mine near the site, and ash disposal lagoons. The power plant design calls for up to four 300 MW units to be constructed. Present plans are to build two 300 MW units, of which the first has been completed and the second is under construction. For two 300 MW units, 220 tons of coal per hour would be used. The ash is disposed of to a lagoon about 40 hectares in size. Initially there are three lagoons, each with a capacity of 300,000 to 530,000 meters^3. The lagoons are lined with a 600 mm layer of clay. The discharge from the lagoons will be recirculated. Seepage entering the ground water discharges into the East Fork of the Poplar River. This is estimated to be 2 liters/sec or less.

The permit for operation of the ash lagoons issued to SPC by Saskatchewan Department of the Environment specifies that ash recirculating water may not be discharged to Cookson Reservoir or the East Fork. If seepage to the East Fork below Morrison Dam exceeds 2 liters per second, mitigation measures must be submitted to Saskatchewan Environment. The permit also specifies a detailed surface and ground water monitoring program.

Emission rates from two 300 MW units (with a single stack) are estimated as follows:

- 10,732 pounds/hour sulfur dioxide (SO_2)
- 450 pounds/hour particulates (TSP)
- 3,600 pounds/hour oxides of nitrogen (NO_x)

Present plans call for no SO_2 or NO_x control and 99.5 percent particulate control using an electrostatic precipitator. The permit for operation of the first 300 MW unit includes requirements for ambient air quality monitoring and in-stack sampling.

Because the power plant operations and reservoir will result in consumptive water use and will modify the natural transboundary flow of the Poplar River, it is expected that a flow apportionment agreement will be established between the U.S. and Canada. The International Joint Commission (IJC) was asked to investigate apportionment.

The International Joint Commission was created by the Boundary Waters Treaty of 1909. The Treaty was enacted to review questions or disputes on the use of boundary waters and other issues. The IJC is a bilateral body composed of three commissioners each from the United States and Canada. The IJC requested that an investigation of flow apportionment be made by the International Souris-Red River Engineering Board. The Poplar River Task Force was formed in April 1975 and studied 22 different apportionment alternatives. In April 1978 the IJC recommended to the governments an equal division of flow at the boundary based on the schedule referred to in this report as Apportionment VI. In August, 1977 the IJC was also asked to study present water quality and water uses and to identify any effects of flow apportionment, the SPC power plant, reservoir and associated development, and other possible developments in the basin. In addition the IJC was asked to recommend measures to ensure that Article IV of the Boundary Waters Treaty of 1909 would be honored. This provision states that the boundary waters "shall not be polluted on either side to the injury of health or property on the other." The IJC report on water quality, including its recommendations, was completed in January 1981.

Prior to the U.S. entering into a flow apportionment agreement, a determination was made to complete an Environmental Impact Statement (EIS) as required by NEPA. This EIS reviews the integrated impacts of power plant and reservoir operation and flow apportionment on the Poplar River Basin and associated areas within the U.S. Changes in water quantity and quality and air quality are evaluated and the resulting socioeconomic and biological impacts assessed. As part of the NEPA requirements, a public hearing on the Draft EIS was held on September 23, 1980 in Scobey, Montana. The public comment period was open until October 20, 1980. Chapter 7 of this document includes a list of respondents from the public hearing and from written comments. Complete written responses and excerpts from the public hearing are included in Appendix J along with responses to these comments.

1.2 Water Quantity Impacts

The Poplar River is a meandering prairie stream with a mean annual flow near Poplar, Montana of 92,560 ac-ft (127.8 cfs). About 35 percent of that flow comes from Canada. The flow has a wide seasonal and yearly variability. For example, the annual flow on the East Fork at the border has ranged between 2,640 and 46,790 ac-ft. The winter and summer are low flow periods with about three-fourths of the annual flow coming from snowmelt in March or April. Surface water uses in the Poplar Basin include municipal uses, stock reservoirs, and irrigation.

1.2.1 Flow Apportionment Alternatives

The flow apportionment alternatives analyzed are shown in Table 1.2-1. Three basic apportionment divisons of the total natural flow of the Poplar River at the International Border between the U.S. and Canada were considered. These are a 50:50 division between the two countries with no restrictions on flow reduction in a given fork of the Poplar River, a 50:50 division with various restrictions on maximum flow reductions, and a division stating that 70 percent of the flow could be used by Canada and 30 percent would pass to the U.S. A no-action case (i.e., no apportionment case) was also evaluated which allowed Canada to use all of the flow within the Canadian part of the basin to estimate worst case conditions. There were five different sets of flow reduction restrictions evaluated in the EIS. These are shown as Apportionment IIIa and b, IVa and b, and VI in Table 1.2-1. Apportionment VI is the one recommended by the IJC (1978). This case is used to analyze impacts on agriculture, water supplies, and biota in Chapter 5 of the EIS. The alternative apportionments are compared to Apportionment VI in Chapter 3 on alternatives.

Under the recommended apportionment (VI), when fully implemented the flows would be reduced by up to 50 percent of the natural flow on the West Fork and reduced by up to 40 percent of the natural flow on the Middle Fork. Flows on the East Fork would be made up of a continuous release from the Cookson Reservoir of 1 to 3 cfs and additional scheduled releases. The scheduled releases to the East Fork under Apportionment VI would be between 300 and 1,000 ac-ft distributed throughout the irrigation season (Table 1.2-2). The summer flows on the East Fork are predicted to be from 35 to 65 percent less with one 300 MW unit operating and up to 80 percent less with four 300 MW units operating.

The flows predicted under the recommended and alternative apportionments are compared in Chapter 3 for critical months. March is important for livestock, fish and wildlife, and spreader irrigation. June through September is the primary irrigation season. None of the apportionments provide enough water for all projected U.S. demands to be met. Demands for spreader irrigation in March can be met at both the Middle and West Forks under Apportionments IVa and VI through the year 2000. Median flows on the West Fork are about 57 ac-ft less under Apportionment IVa than under Apportionment VI. Peak flows are slightly lower under Apportionment IVa than under Apportionment VI.

On the Middle Fork, median and peak flows in June are lowest for Apportionment V. Peak flows on the Middle Fork are highest under Apportionment IVa than the other cases. Peak flows on the West Fork are highest under Apportionment IVb. Flows for July through September are at very low levels (less than 3.2 ac-ft per month) for the same months. Summer irrigation demands are exceeded for the same months and frequencies for Apportionment IVa and VI. More water is available at peak flow conditions under Apportionment VI. Summer flows are not adequate on either the Middle or West Fork to meet all the irrigation demand. The large decreases in flow on the Middle Fork make Apportionment V and IVb less desirable than VI. In summary, Apportionment VI appears to provide the most flow compared to the other alternatives. The increased flows in March on the Middle Fork under Apportionment IVa would be beneficial to fish and wildlife. However, this would be offset by decreased flows on the West Fork during the irrigation season.

1.2.2 Impacts on Beneficial Uses of Flow Apportionment

The impacts of the reduced flows on municipal, stock, and irrigation uses were assessed using the results from the KARP II model of the Poplar

Table 1.2-1

DESCRIPTIONS OF APPORTIONMENT ALTERNATIVES

Percent of Flow to United States					
Apportionment	West Fork+	Middle Fork+	East Fork	Other Trib.	Model Scenarios
II	50 percent division no restrictions				--
IIIa	40	60	30-50	40	10-12*
IIIb	60	40	30-50	40	7-9*
IVa	40	60	Releases**	100	18-22
IVb	60	40	Releases	100	13-17
V	30	30	Releases	100	23-27
VI	50	60	Releases	40	28-32

---

*These scenarios did not include Cookson Reservoir or power plants, so will not be discussed.

**The volumes of releases are at least 1 cfs. The specific releases are listed in Table 1.2-2.

+The flows include the flow of the nearby tributary.

Table 1.2-2

RESERVOIR RELEASES ON THE EAST FORK OF THE POPLAR RIVER

Flow at Station 4[+]	Continuous Release		Scheduled Release	
Acre-Feet	Acre-Feet	Months	Acre-Feet	Months[++]
0-3,800	60	All year	300	May-September
3,801-7,500	60	September-May	500	May-September
	120	June-August		
7,501-12,000	120	September-May	500	May-September
	180	June-August		
>12,000	120	September-May	1,000	May-September
	180	June-August		

[+] Sum of March through May flows at the Middle Fork below the confluence with Goose Creek.

[++] Schedule for releases is based on irrigation need as follows:

Month	May	June	July	August	September
Percent	12	18	32	27	11

Amount of releases from scenario descriptions of Montana Health and Environmental Sciences.

River. The model was run for natural, historical (1933-1974), and existing conditions, six apportionment proposals, unlimited Canadian uses, and two cases with the water discharged from the ash lagoon routed to Cookson Reservoir instead of recirculation of the discharged water as presently planned. Table 1.2-3 summarizes the year simulated and the number of generating units for each of these cases. The twelve stations where flows were reported by the model are shown in Figure 1.2-1.

The Sioux and Assiniboine Tribes of the Fort Peck Indian Reservation claim rights to all the water of the Poplar River which they can use based on the treaty which established the Fort Peck Indian Reservation. The tribe states that the Winters vs. United States case in the U.S. Supreme Court, which determined that the tribes have prior rights to the water for present and future development, applies here and confirms that no limit on future uses of water was included by the original treaty. This claim is not analyzed in this document. Rather, the impacts of flow apportionment on the Fort Peck Indian Reservation are based on the projected water uses including the proposed irrigation project and whether flow and quality of the Poplar River are adequate to meet the projected demands.

1.2.2.1 Municipal Water Supply

The major impacts in the U.S. under Apportionment VI are summarized by water use with and without the Cookson Reservoir and for water uses in 1975, 1985 and 2000, including one to four 300 MW power plant units. The only municipal uses of Poplar River water are for Scobey, Montana. The model used a conservative approach in that all water is withdrawn from the Lower East Fork. In reality, the water is withdrawn from wells close to the river below the confluence of the East and Middle Forks. The annual municipal water uses are projected to increase from 350 ac-ft in 1975 to 400 ac-ft in 1985 and 600 ac-ft in 2000. The monthly demand varies from 4 percent of the annual use (e.g., 14 MGD in January for 1975) to 16 percent of the annual use (e.g., 56 MGD in July for 1975). Municipal water demands can be met in all months for 1975 and 1985. The full projected demands for the year 2000 with three or four 300 MW units operating can be supplied in August in very dry years only if all the river water was withdrawn. Of the projected demand of 90 ac-ft for August in the year 2000 most of the use over 30 ac-ft would be for outdoor uses (e.g., lawn and garden sprinkling, car washing).

1.2.2.2 Stock and Spreader Irrigation

Spring runoff peak flows could decrease under the apportionment plan after full implementation at all the border stations but would decrease the most on the East Fork. At present, the flows on the Middle and West forks would be more than set by the apportionment because there are not adequate storage reservoirs in Canada to retain their allotted flow. A new reservoir is proposed on the Middle Fork for the year 2000 in Canada. The peak flows supply water for filling reservoirs, which are then used for stock water and later irrigation, and for irrigating land by the spreader method. The peak flows also scour the river channel and clean out sediment and vegetation

Table 1.2-3

SUMMARY OF FLOW SCENARIOS

Scenario No.	Flow Type	Level of Development	No. of 300 MW Units
1	Natural	Predevelopment	0
2	Historical	Historical 1933-1974	0
3	Existing	1975 & Cookson Res.	0
28	App. VI*	1975	1
29	App. VI	1985	2
30	App. VI	1985	3
31	App. VI	2000	3
32	App. VI	2000	4
4A	App. VI+	1975	1
8A	App. VI+	1985	2

*Apportionment VI

+These scenarios include discharge from the ash lagoon entering Cookson Reservoir.

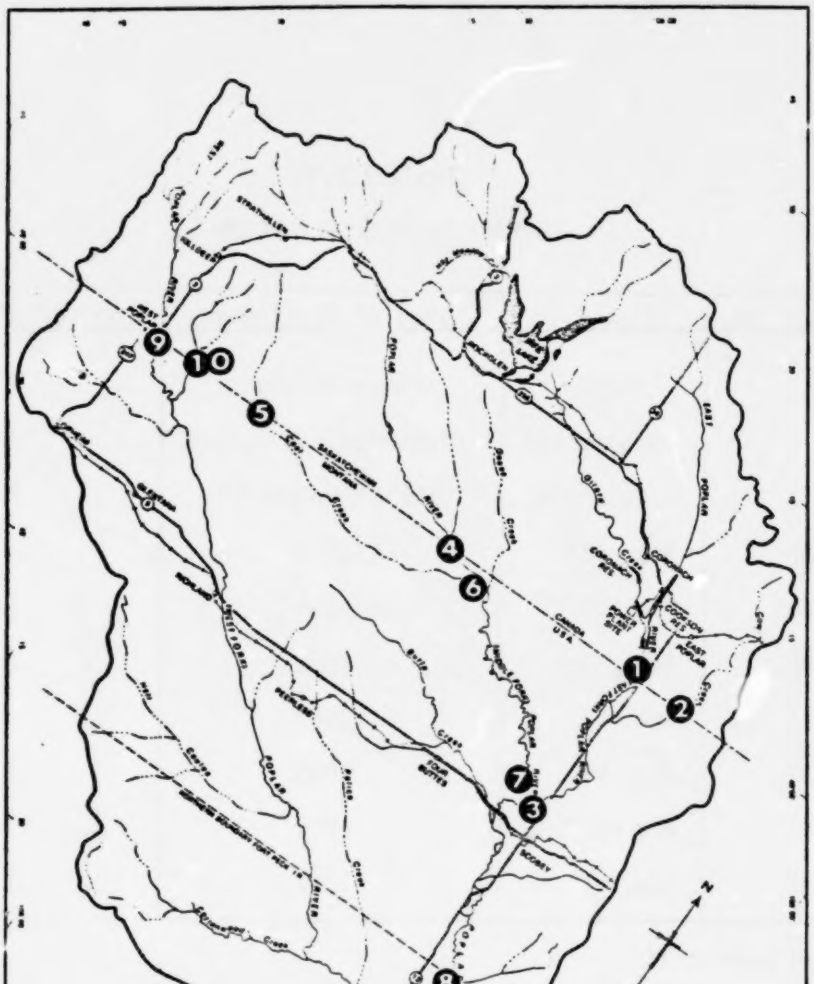

1
2
3
4
5
6
7
8
9
10
11
12
SASKATCHEWAN
MONTANA
CANADA
USA
EAST POPLAR
CORONACH
SCOBEY
POPLAR RIVER BASIN
4 0 4 8 miles
6 0 6 12 kilometers
KEY:
❶ Station for Flow Computations

Figure 1.2-1 LOCATION OF STATIONS USED IN FLOW MODEL

deposited under low flow conditions. This scouring function is important in maintaining fish and wildlife habitat as is discussed in more detail in the biological impacts section. The model allowed spills from the reservoir if it was full. Flows as high as 20 m^3/sec (700 cfs) for two days occur about 30 percent of the time under both natural conditions and with the Cookson Reservoir and two 300 MW units operating (Draper, 1979). The reservoir elevation must be above 751.5 m to allow a release of water volumes greater than the capacity of the riparian outlet of 4.5 m^3/sec (158 cfs). The water uses of spring runoff would occur whenever the peak flows occurred, which can be between March and May. The model considered that all demand for stock water would be supplied by the river. In many cases the stock reservoirs are filled from the smaller tributaries during spring runoff and not from the Poplar River. Demands for water on the main Poplar (station 8) and East Fork (station 3) in the spring cannot be met in dry years either under existing conditions or Apportionment VI.

Stock and spreader irrigation demands can be met on the Lower Middle Fork (station 7) and Lower West Fork (station 11). There are no present or projected water requirements for stock or spreader irrigation on the Upper West Fork (station 9). Historical flows at this location have been low (less than 3.2 ac-ft per month in at least one out of ten years).

Flows at Poplar (station 12) are computed by the model based on the construction by 1985 of two proposed reservoirs on the Fort Peck Indian Reservation. Under 1975 and historical conditions, flows in March were estimated as less than 3.2 ac-ft per month in at least one out of ten years. After the proposed reservoirs are operating, water requirements for stock and domestic uses (802 ac-ft) and spreader irrigation (260 ac-ft) could be met in all years.

1.2.2.3 Summer Irrigation

Part of the summer flows are used for flood and sprinkler irrigation. The model distributed the summer irrigation demand by month according to the following schedule:

Month	Percent of Summer Irrigation Demand
May	12
June	18
July	32
August	27
September	11

This is a conservative approach since historically there have been 2.4 applications per year with little or no irrigation with river water in August and September. Some areas could be irrigated using water from previously filled surface reservoirs or pumping of ground water from deep pools. Comparisons were made between the projected number of irrigated acres and the number of acres that could be irrigated with the available water under Apportionment VI with from one to four 300 MW units operating. The results by month for each river station shown in Table F-1 of Appendix F are summarized here.

Irrigation water requirements on the East Fork for 1,088 acres in 1975 and 1,235 acres in 1985 can be met in all years. The increased acreage of 1,533 acres in the year 2000 can be irrigated in all months except August and September in very dry years. The Middle Fork flows decrease as the summer progresses. The irrigation requirements for 872 acres in 1975, 1,175 acres in 1985, and 1,957 acres in the year 2000 can be supplied under median flow conditions only in June. Peak flow conditions would be needed to meet the full irrigation requirements in July and August. In dry years the number of acres that can be irrigated are less as shown in Table F-1.

The projected irrigation requirements on the main Poplar (station 8) of 1,430 acres in 1975, 1,880 acres in 1985, and 2,920 acres in the year 2000 can be met in June only under median flow conditions and only under high flow conditions the rest of the summer. In the year 2000, in dry years, little or no irrigation would be possible after June. The projected irrigated acreage on the West Fork of 833 acres in 1975 can be irrigated in June through September with median flows. The 1985 projected acreage of 1,380 acres can be irrigated in July through September only under high flow conditions. The projected acreage for the year 2000 of 2,527 acres can be irrigated under high flow conditions in July and August.

Irrigated acreage on the Fort Peck Indian Reservation is projected to increase from 618 acres in 1975 to 10,618 acres by 1985 and to 20,618 acres by 2000. The estimate of increased acreage is based on the completion of the two proposed reservoirs by 1985. The 1975 and 1985 water use demands can be met in all the summer months under median flow conditions. Consideration of carry-over storage in the reservoir from one year to the next is needed to meet the full demands in very dry years. The year 2000 demands can be met if carry-over storage is included. The design capacity of the two reservoirs is 152,400 ac-ft which is considerably more than the annual total water demands of 56,848 ac-ft plus estimated annual reservoir evaporation of 4,924 ac-ft. Small releases from the proposed reservoirs would be needed to supplement in-stream flows and to supplement downstream flows for flood irrigation demands which are estimated as a maximum of 100 ac-ft.

In summary, with respect to irrigation, the total projected irrigated acreages in the U.S. part of the Poplar River Basin are as follows:

Year	Irrigated Acres	Net Demand, ac-ft
1975	4,841	7,235
1985	16,288	36,719
2000	29,555	67,532

In dry years the total demand could not be met under Apportionment VI or historical conditions without considering carryover storage. The West Fork has the least amount of water available for irrigation. Flows in all the forks are less in August and September, thus fewer acres can be irrigated in these months.

1.2.2.4 Winter Flows

Winter flow conditions are important for maintaining fish habitat. The model assumed that the upper reaches of the Poplar could freeze. Thus the flows were considered to be less than 3.2 ac-ft per month on the West Fork and tributary at the International Boundary (station 9) for December through February. Flows were considered to be less than 3.2 ac-ft on the Middle Fork at the International Boundary from January through March unless an early thaw occurred for a given year (Poplar River Task Force, 1976, Appendix B).

1.2.2.5 Flow Impacts on Biota

The Poplar River supports fishable populations of two important gamefish species, walleye and northern pike. Both of these species have specific habitat requirements which are influenced by streamflow. Fisheries data collected by Stewart (1980) indicate that adequate flow during the spring runoff period is especially important to successful spawning and rearing of gamefish. Peak flows are also important in maintaining the present riffle-pool configuration which provides both spawning and overwintering habitat.

Analysis of predicted flows under Apportionment VI and historical gamefish spawning data indicate that in average years with up to two 300 MW units operating (1985 water uses) there will be continued gamefish spawning in the East Fork. However, in dry years (i.e. the lower 10 percentile flow) with one or more units in operation there would be little gamefish reproduction in the East Fork.

With one 300 MW unit in operation under Apportionment VI, there will also be a reduction in the mean abundance of young gamefish in the East Fork when compared with historical levels. This reduction in young of the year class recruitment would be greater with additional units. It is not possible to accurately predict the effects of reduced production of young fish on the relative numbers of adult gamefish in the East Fork. However, due to the apparently limited migrations of adult gamefish, there is a potential for a reduction of catchable gamefish in the East Fork under the apportionment.

The preceding impact predictions have been based upon the annual production of young fish as a function of spring flow assuming adequate spawning and rearing habitat is available. An additional potential impact of apportionment is the reduction of peak flows which are necessary to maintain the current gamefish habitat. Available data indicate that peak spring flows of about 20 m^3/sec (700 cfs) would be required to maintain the present channel configuration. The precise required duration and annual frequency of such flows are difficult to predict; however, a duration of 2 days has been recommended by the International Poplar River Water Quality Board (IPRWQB) of the IJC and is supported by sediment transport calculations. Historical flow data indicate that such flows have existed in approximately 1 year out of every 3 years (Draper, 1979).

Cookson Reservoir and operation of the power plants could potentially reduce the magnitude and/or duration of peak flows necessary for maintenance of channel configuration. The minimum scheduled release under flow apportionment of 300 ac-ft would not provide the required spring peak flow. Moreover, this release has been considered in the modeling efforts as providing additional water during the irrigation season and its use as a single spring flow to scour the channel would result in lower subsequent flows during the irrigation season. However, available data indicate that with up to two units there would be sufficient water available to attain the natural frequency (i.e. about 30 percent) of 2-day 700 cfs flows by spilling water from the reservoir. Operation of three or more 300 MW units would result in severe reduction in the availablity of spills of the magnitude of 700 cfs over two days. Therefore, with one or two units in operation appropriate reservoir operation could be used to mitigate against loss of the riffle-pool configuration necessary for gamefish survival and reproduction.

Changes in the channel configuration may also affect other biota which require specific aquatic habitats. The two groups most likely to be affected are furbearers and waterfowl. Decreased duck production may occur in the Upper East Fork due to macrophyte encroachment (growth of aquatic vegetation). However, increased growth of aquatic vegetation in the lower East Fork and main Poplar River may result in partially offsetting the decreased duck production in the Upper East Fork. The changes in flow regime are not predicted to result in adverse impacts on furbearers since they are not directly dependent on large peak flows.

1.2.3 Impacts on Ground Water

The three major aquifers in the Canadian part of the basin are the glacial drift including the Empress Formation, the Ravenscrag Formation and the Frenchman Formation. The major aquifers in the U.S. part of the basin are alluvium, glacial deposits, Wiota gravels, Flaxville Formation, Fort Union Formation, and the Fox Hills-Hells Creek formations. The characteristics of the these aquifers and a discussion of ground water quality is included in Chapter 4 and Appendix A-4.

Ground water throughout the basin is used for domestic water supplies, stock watering, and to a limited extent irrigation. The analysis of impacts in this EIS is restricted to the U.S. part of the basin. Impacts could occur due to changes in flow regime caused by dewatering of the mine site, leakage from the ash disposal ponds, and leakage from Cookson Reservoir. The primary effects of these activities will occur in the Canadian part of the basin and so are not discussed. The predicted impact of these activities on ground water in Montana are summarized here. The maximum predicted decline in water levels in the Fort Union Formation due to dewatering at the border directly south of the mine site is 0.7 meters after 35 years. The maximum rise due to leakage from the reservoir at the border is 0.1 meters after 75 years (IPRWQB 1979). The higher water level near the East Fork at the border could result in new areas of saline seep.

The amount of ash lagoon seepage is important because of effects on ground water levels and on river and ground water quality. SPC's design of the ash lagoon system changed during the preparation of the EIS. Presently, the ash lagoons are lined with a compacted clay layer and the ash lagoon discharge (decant) recirculated. The estimated seepage to the ground water and ultimately, the East Fork under these conditions is 2 liters per second or less. Because the ground water flow in the glacial drift is approximately parallel to the border and in the direction of the East Fork, the primary effects on water quality are in the East Fork. The ash lagoon seepage could add increased levels of total dissolved solids, boron and trace metals to the East Fork. The river model results for the worst case with all the ash lagoon seepage discharging directly to Cookson Reservoir show that higher TDS and boron concentrations would occur in the East Fork. The lining of the lagoons and recirculation is expected to mitigate water quality impacts.

1.3 WATER QUALITY IMPACTS

Water quality in the Poplar River was simulated using Karp III and the Modified Montreal Engineering (MME) model of the Cookson Reservoir. The quality of transboundary flow was calculated on the basis of upstream water quality plus ground water seepage, irrigation return flow, and runoff as well as simulated reservoir water quality. The water quality of the Poplar River was simulated at the stations shown in Figure 1.2-1 for the different apportionment alternatives and 1975, 1985, and year 2000 levels of development. Table 1.2-3 summarizes the major scenarios discussed in Chapter 5. Scenarios 28 through 32 include natural and forced evaporation from Cookson Reservoir but not ash lagoon seepage. At the time of the modeling work, SPC's plans for operating the ash lagoons had not been finalized. The MME model was used to simulate water quality in Cookson Reservoir when all the ash lagoon decant was discharged directly to the reservoir (Scenarios 4A and 8A). As discussed previously, this scenario will not occur but does provide a worst case analysis. The parameters which were modeled and are discussed here are total dissolved solids (TDS), boron, sulfate, and the sodium adsorption ratio (SAR).

1.3.1 Total Dissolved Solids

Historical TDS concentrations on the East Fork at the border range from 153 mg/l in March to 1784 mg/l in January. In general, the highest concentrations occur in the winter and lowest concentrations occur during the spring runoff period (April and May). Under Apportionment VI, the range of concentrations increases as follows:

Range of TDS, mg/l	No. of 300 MW Units	Year
260-1064	1	1975
288-1345	2	1985
330-2079	3	1985
330-2079	3	2000
381-4796	4	2000

These concentrations can be compared to predicted 1975 conditions with Cookson Reservoir but without apportionment or the power plant, which range from 243 mg/l in May to 925 mg/l in November.

Downstream stations are affected by the flow apportionment operation of the power plant and irrigation return flows. For example, the range of TDS concentrations for 1975 with one 300 MW unit operating is 407 to 1269 mg/l on the main Poplar (station 8), and 345 to 1308 mg/l near the mouth of the Poplar River (station 12). Detailed tables showing concentrations by month and station for three probability levels are included in Appendix G.

The IJC has proposed interim water quality objectives during March through October on the East Fork at the International Boundary (IJC, 1981). The recommendations are a maximum long-term flow-weighted average concentration of 1000 mg/l and a maximum flow-weighted concentration of 1500 mg/l for any three consecutive months. For the period after construction of the reservoir but without an apportionment or an operating power plant TDS concentrations on the East Fork at the border from March 1975 through September 1978 ranged from 97 mg/l in March 1976 to 1480 mg/l in July (USGS data). Thus, these objectives would have been met. The model results indicate that the objectives could be met with Apportionment VI and up to two 300 MW units operating. With three units operating, TDS concentrations during drought years could exceed the 1500 mg/l criteria during three consecutive months. With four units operating both the proposed criteria could be exceeded.

The high TDS concentrations may result in water at Scobey's municipal wells having concentrations above the EPA secondary drinking water standard of 500 mg/l. Water with TDS concentrations above 1300 mg/l may be unacceptable as a potable water supply. Such concentrations have occurred in the past when Fife Lake overflowed into Girard Creek which drains into Cookson Reservoir. The model predicts that concentrations in the East Fork at Scobey above 1300 mg/l can occur in the winter with two or more 300 MW units operating in one year out of ten. With four 300 MW units, concentrations above 3000 mg/l on the East Fork could affect poultry. The impacts of TDS on crops are discussed in a separate section (1.3.5).

1.3.2 Sulfate

Water quality modeling results for sulfate indicate that concentrations above 250 mg/l, the EPA secondary drinking water standard, occur for historical conditions in one year out of ten during the low-flow period of August through March. Under Apportionment VI with up to two 300 MW units operating this standard would be exceeded in all months in one out of ten years. Modeling results indicate that operation of three or more units would result in significant increases in SO_4 and maximum concentrations could exceed 800 mg/l. Concentrations above 500 mg/l can cause toxic effects on plants. Such concentrations could occur on the East Fork in dry years.

1.3.3 Boron

Boron concentrations are of concern due to the sensitivity of some plants to boron. Boron concentrations on the East Fork at the border after construction of Cookson Reservoir during January 1976 through September 1978 ranged between 0.12 mg/l and 2.0 mg/l. From March to December 1975 boron concentrations were between 1.0 and 3.1 mg/l (U.S.G.S. data). The IJC has proposed objectives for March through October specifying a long-term flow-weighted average boron concentration of 2.5 mg/l and a maximum flow-weighted average concentration during any three consecutive months of 3.5 mg/l.

Predicted boron concentrations with up to two 300 MW units operating and Apportionment VI were 2.5 or below from March through October. Higher concentrations (up to 20 mg/l at the East Fork at the border) could occur if ash lagoon decant was discharged to Cookson Reservoir. As discussed earlier, present plans of SPC call for recirculation of the ash lagoon decant and limiting seepage to the East Fork to less than 2 liters/sec. With Apportionment VI and four 300 MW units operating concentrations on the East Fork at the border between March and October could increase to 8 mg/l in one out of ten years. For stations further downstream, concentrations for these same conditions would decrease to below 4 mg/l. The effects of boron on crops are discussed in Section 1.3.5. Boron at these concentrations is not likely to cause damage to livestock. There is no drinking water standard for boron.

1.3.4 Sodium adsorption ratio

Sodium adsorption ratio (SAR) was predicted as a conservative parameter by the model. However, since SAR is not truly a conservative parameter, actual downstream values are probably higher than indicated by the model. The SAR results are used in combination with the salinity (TDS) concentrations to estimate effects on crops.

1.3.5 Combined Water Quality Impacts on Crops

The possible effect of power plant operation on crop yields due to airborne and waterborne pollutants were investigated. This section discusses impacts from waterborne pollutants on irrigated crops. The effects of three constituents on crop yield were investigated-- those of boron, salts, and sodium. Three factors are of paramount importance in determining crop yield impacts. These are: 1) the concentration of the constituent in irrigation water, 2) the attenuation or magnification of the concentration in the soil, and 3) the response of the plant to soil concentrations.

The concentration of these substances in the Poplar River was estimated under several development scenarios using the river models as discussed earlier for the period of the irrigation season (April to September). These were the constituent levels used to predict crop impacts.

The procedure used to predict crop impacts is discussed in detail in Appendix G. Natural soils have a capacity to adsorb boron. The partitioning of boron between the soil water and solid phases is primarily a function of concentration within a range of temperature, pH, and soil moisture. A mass balance approach was used for estimating salinity and SAR (sodium adsorption ratio) in the soil. Leaching, rainfall, and varying water quality levels were again accounted for as described in Appendix G.

Crop yield estimates were made for the major irrigated crops (e.g., wheat, barley, alfalfa, and oats) in the East Fork sub-basin and the Fort Peck Indian Reservation. The responses of these crops to boron, salinity, and sodicity were determined by extensive review and analysis of available literature. Salinity and sodicity responses have been studied more and are better defined. Crop yields were assessed using an empirical function of soil electrical conductivity (EC) and SAR. The interactive effects of boron, and EC and SAR were assumed to be independent as no data currently exist to justify the evaluation of synergistic effects.

Baseline conditions for comparison of yield changes were considered to be scenario 3 (1975 development conditions with no apportionment and no power plant operation) assuming a leaching fraction of 0.2 and median rainfall. Relative yields under other scenarios were subtracted from these to determine relative yield differences.

The analyses show that the effects of salinity/sodicity on crop yields are greater under future development scenarios than the effects due to boron. Detailed tables showing yield changes by scenario and rainfall and water quality probabilities are included in Appendix G. Wheat, alfalfa, barley and oat losses in the East Fork subbasin under average water quality, precipitation quantity, and a 0.2 leaching fraction were (in percent reduction) -3, -3, -4, -4 with one 300 MW unit and 1975 conditions, and -6, -7, -8, -12 with a 600 MW unit and 1985 conditions, respectively. The percent yield reductions for the Fort Peck Indian Reservation were -2, -3, -3, -6 with a 300 MW unit and 1975 conditions for the same crops as above. During low rainfall years in conjunction with poor water quality, losses would be greater with two 300 MW units operating as shown in Tables G.1-2 through G.1-5 in Appendix G.

Variation in crop yields can be due to climatic variation alone. Precipitation occurrence and availability of water for leaching appear to have a potentially greater impact than increasing the number of power plant units. Increasing the leaching fraction results in much less loss of yield. However, this must be balanced against the fact that fewer acres can be irrigated. In dry years availability of this extra water is unlikely.

1.3.6 Water Quality Impacts on Fishes

Changes in total dissolved solids (TDS) due to power plant operation and flow apportionment may affect fishes inhabiting the Poplar River. Eggs and larvae are generally more sensitive than adults to TDS increases; therefore, the major concern is associated with impacts on reproductive success.

Modeling results indicate that operation of two or more units will result in April TDS concentrations exceeding tolerance limits for successful gamefish reproduction in the East Fork during dry years (i.e. one out of every ten years). With operation of four units, the TDS concentrations would limit successful gamefish spawning in all years. Such effects would be confined to the East Fork since dilution after confluence with the Middle Fork would reduce TDS levels below the concentrations affecting fish reproduction. Changes in other modeled water quality constituents are not expected to result in adverse effects on fish populations.

Analyses of gamefish muscle tissues indicate mean mercury concentrations of about 0.5 mg/wet kg in the East, Middle and West Forks of the Poplar River. The highest values were about 0.9 mg/wet kg, slightly less than the current U.S. Federal Drug Administration action level of 1.0 mg/wet kg. These data indicate a significant accumulation of mercury in fishes throughout the upper reaches of the Poplar River with no known source identified to date. Since mercury and other metals may be released to the environment during coal combustion, the occurrence and distribution of heavy metal contamination should be carefully monitored prior to and after power plant operation.

1.4 Air Quality Impacts

Air quality impacts can result from elevated ambient concentrations of airborne gaseous and particulate pollutants. The effects of these elevated pollutant concentrations include respiratory disease, decreased visibility, crop damage and trace metal contamination. Each of these effects are analysed in the EIS. Additionally, ambient air quality and the potential effects of fumigation events, the potential for increased trace metal concentrations in the environment, and the potential effects of SO_2 deposition on soil acidification are summarized here. Emission rates from the SPC power plant at different levels of sulfur dioxide (SO_2) control are compared to other power plants in Table 1.4-1. Without SO_2 control the emissions would be considerably higher than the others. At present there are no emission control standards for power plants in Saskatchewan. The SPC plant has an emission rate of 1.94 pounds SO_2 per 10^6 BTU which exceeds the EPA new source performance standards of 1.2 pounds SO_2 per 10^6 BTU. The emission rates for NO_x and particulates are below the EPA new source performance standards.

1.4.1 Ambient Quality

Ambient concentrations of SO_2, oxides of nitrogen (NO_x), and particulates were predicted using the CRSTER model. The model was run

Table 1.4-1

COMPARISON OF EMISSION RATES FROM SELECTED POWER PLANTS

Plant Name	Plant Location	Size of Plant, MW	Percent SO_2 Control	SO_2 Emission, lbs/hr
Saskatchewan Power Corporation Poplar River Units 1 & 2	Coronach, Saskatchewan	600	0[a] 60 90	10,732 4,636 1,159
Cooperative Power Association United Power Association Coal Creek Station	Underwood, N. Dakota	two 500 units	74.4	6,970
Otter Tail Power Co. Coyote #1	Beulah, N. Dakota	440	70.2	5,335
Square Butte Elec. Power Coop. M. R. Young Station #2	Oliver County N. Dakota	440	66.3 overall	4,536
Colstrip Unit #1 #2	Colstrip, Montana	358 358	75 75	827 1,175

[a] No stack controls are included, but 8 percent of the SO_2 is considered to be retained in the ash.

[b] Estimated value only.

Data are from EIS and Air Quality Control Permit Applications for North Dakota and Montana.

twice, once using meteorological data from Glasgow, and once using the recently collected data from Scobey. The latter modeling was performed by the Montana State Air Quality Bureau (Gelhaus, 1980). The estimated maximum ambient concentrations from both modeling studies are shown in Table 1.4-2 for a 600 and 1200 MW plant. Both predictions for SO_2, NO_x and particulates are below the U.S. National Ambient Air Quality Standards and the Montana Air Quality Standards for 1-hour, 3-hours, 24-hours, and the annual mean. The maximum predicted increases in SO_2 concentrations consume between 31 and 41 percent of the allowable 24 hour prevention of significant deterioration (PSD) Class II increases for a 600 MW plant and between 62 and 100 percent for a 1200 MW plant as shown in Table 1.4.2. The increases in particulate concentrations represent less than 2 percent of the allowable PSD Class II increases.

The PSD requirements for Class I areas are more restrictive than for Class II areas. The CRSTER model predictions were used to determine whether violations of the PSD Class I standards could occur at the Medicine Lake Wildlife Refuge located about 65 miles southeast of the plant and at the Fort Peck Indian Reservation boundary located 30 miles directly south of the power plant at its closest point. The reservation is not a Class I area but may be designated as one in the future. The predictive capability of the CRSTER model falls off rapidly at distances over 48 km (30 miles) but it can be used to provide an upper limit concentration. The predictions at these distances would be very conservative due to the use of average wind speeds and directions which are not a function of distance, lack of vertical variation of dispersion coefficients, and lack of pollutant loss with distance due to chemical processes and deposition.

The maximum 24-hour SO_2 concentration for a 1200 MW plant with no SO_2 control at the wildlife refuge was predicted to be 9.2 micrograms per cubic meter (ug/m^3) by Gelhaus (1980) and 7.1 ug/m^3 in this document. Both concentrations are above the PSD Class I standard (for SO_2 of 5 ug/m^3). Predictions with 60 and 90 percent SO_2 control show that 90 percent control would be required to meet the PSD Class I standards for SO_2 for a 1200 MW plant at both the wildlife refuge and the Fort Peck Indian Reservation.

For a 600 MW plant the predictions indicate that PSD Class I standards for SO_2 at the Fort Peck Indian Reservation would be met with 60 percent control, although the predicted values are within 1 ug/m^3 of the standard (Table 1.4-3). The predictions by Gelhaus indicate that 60 percent control is not enough. For a 300 MW plant, the predictions in this document are equal to the maximum 24-hour SO_2 standard while the Gelhaus predictions exceed both the maximum 3-hour and 24-hour SO_2 standards. Using 60 percent control for a 300 MW plant would meet the standards based on Gelhaus' predictions. Particulate PSD Class I standards are not exceeded by either prediction with 99 percent control of the particulates.

Table 1.4-2

ESTIMATED MAXIMUM POLLUTANT CONCENTRATIONS IN MONTANA FROM THE POPLAR RIVER POWER PLANT

(Concentrations in micrograms per cubic meter)[a]

Pollutant	Time Period	Power Plant Size		NAAQS[b]	Montana AAQS	PSD Class II	MCD[c]	Sask[d] AAQS
		600 Mw	1200 Mw					
Sulfur Dioxide	1-hour	400 (214)[e]	800 (428)	--	1300	--	450	450
	3-hour	166 (96)	332 (192)	1300	--	512	--	--
	24-hour	46 (28)	92 (56)	365	265	91	150	150
	Annual	1.6 (2.4)	3.2 (4.8)	80	55	20	30	30
Nitrogen Oxides	1-hour	134 (74)	268 (148)	--	564	--	--	400
	Annual	0.6 (.79)	1.2 (1.6)	100	94	--	60	100
Particulates	24-hour	2.0 (2.6)	4.0 (5.2)	150[f]	200	37	--	120
	Annual	0.06 (.2)	0.12 (.4)	60[f]	75	19	60	70

[a] Note - higher concentrations have been predicted using a fumigation model. However, the duration time remains uncertain. SO_2 concentrations assume zero percent control; particulate concentrations assume 99 percent control.

[b] National Ambient Air Quality Standards

[c] Maximum Canadian Desirable Criteria

[d] Saskatchewan Ambient Air Quality Standards

[e] Numbers in parentheses are predicted concentrations in this document

[f] Secondary Standard

Table 1.4-3

PREDICTED MAXIMUM SO_2 CONCENTRATIONS AT THE FORT PECK INDIAN RESERVATION BOUNDARY

Time Period	Allowable PSD Increment Class I	300 MW[a]						600 MW[a]						1200 MW[a]					
		Percent Control						Percent Control						Percent Control					
		0		60		90		0		60		90		0		60		90	
		A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B
3 Hour	25	49	12.5	20	5	5	1.2	98	25	39	10	9.8	2.5	196	50	78	20	2.0	5
24 Hour	5	11	5	4.4	1.8	1.1	0.5	22	10	8.8	4	2.2	1	44	20	17.6	8	4.4	2
Annual	2	0.4	0.5	0.16	0.2	0.04	0.05	0.8	1	0.3	0.4	0.08	0.01	1.6	2	0.6	0.8	0.2	0.2

Note: All values are in ug/m^3. Values under A are from Gelhaus, 1980. The values under A for 60 and 90 percent control are calculated values. Values under B are from Chapter 5 of this document.

[a] Power plant size

1.4.2 Fumigation

Fumigation may cause high ground-level concentrations of pollutants in a narrow area for short periods (less than an hour) during the breakup of a low level inversion. Estimates of concentrations due to fumigation are made in this document and by the Montana Air Quality Bureau (Gelhaus, 1980) using Turner's method (Turner, 1969). Estimated concentrations for SO_2, NO_x and particulates are calculated for January, April, July, and October meteorological conditions. Estimates in this document are also made for more severe meteorological conditions when a strong surface inversion is present and wind speeds are very light. Table 1.4-4 presents estimated SO_2 concentrations for a 600 MW plant for all the cases analyzed in this document and by Gelhaus (1980). These values are based on no SO_2 control. As discussed previously if the Fort Peck Indian Reservation is designated a Class I area then 60 percent control or higher would be required to meet the PSD regulations, the fumigation concentrations would be less than those presented here.

The estimated SO_2 concentrations were compared to the threshold limit for the most sensitive species of 0.5 ppm (1330 ug/m^3) (EPA, 1973) which is below the one hour threshold limit reported for damage to barley of 0.7 ppm (1860 ug/m^3) (Dreisinger and McGovern, 1970) and to alfalfa of 1.15 ppm (3060 ug/m^3) (Stevens and Hazelton, 1976). Comparison of SO_2 plant exposure experiments and fumigation concentrations indicate no damage would be expected at distances greater than 7 km from the power plant under typical stability conditions with projected exposures. At a distance of 6 km from the power plant under typical stability conditions and at distances of between 6 and 10 km, under more severe conditions, some damage is possible to SO_2 sensitive species with exposures for one hour at levels greater than 0.5 ppm (1330 ug/m^3). However, at a short distance from the plume centerline, the concentrations decrease rapidly. At a distance of 500 m from the plume centerline the concentration would be 25 percent of the value at the centerline.

Most of the experimental exposures have been conducted at exposure periods greater than one hour, and it is difficult to relate long and short exposure effects. In addition, fumigation occurs over a small area at any one time, and the frequency of multiple exposures at the same site cannot be predicted. The field tests discussed here and the fumigation estimates indicate that there is the potential for damage to crops and vegetation at a 6 km distance in the area directly south of the power plant. However, it is likely that most fumigation events would occur at greater distances (e.g. between 10 and 20 km from the plant).

If fumigation occurred for 15 minutes, ambient standards would be violated for short time periods. Using the fumigation estimates in this document under typical meteorological conditions and estimated ambient concentrations at 6 km ambient standards are violated for a 1200 MW plant but not for a 600 MW plant. Using the estimates from Gelhaus, 1980, for fumigation and ambient concentrations, violations occur for both a 600 and 1200 MW plant. While this is true under certain conditions, the area involved would be small. The area which is more likely to be exposed to fumigation consists of a 10-km wide band between 10 and 20 km from the power plant and between the 110 degree and 250 degree azimuths.

Table 1.4-4

COMPARISON OF CALCULATED SO_2
DUE TO FUMIGATION, FOR 600 MW PLANT

Month	Downwind Distance (KM)	SO_2 Concentration,[a] ug/m^3	
		EPA[b]	Montana[c]
"Typical" January	10	912	-----
"Typical" January	20	484	-----
January 1978	6	---	7,580
January 1979	6	---	5,918
"Typical" April	10	863	-----
"Typical" April	20	457	-----
April 1978	6	---	7,424
April 1979	6	---	No. calc.
"Typical" July	10	822	-----
"Typical" July	20	484	-----
July 1978	6	---	5,882
July 1979	6	---	6,060
"Typical" October	10	568	-----
"Typical" October	20	301	-----
October 1978	6	---	5,962
October 1979	6	---	4,860
Severe Meteorological Conditions	10	2,016	-----
	20	1,301	-----

[a] Ground-level, plume centerline concentrations with no SO_2 control.

[b] Data are from Chapter 5 of this document.

[c] Data are from Gelhaus, 1980.

The maximum NO_x and particulate concentrations due to fumigation at a distance of 10 km from the power plant are estimated as follows:

	600 MW	1200 MW
NO_x, ug/m^3	676(306)[a]	1352(612)
Particulates, ug/m^3	85(38)	170(76)

[a] The values in parentheses are for typical meteorological conditions. The higher values are for more severe meteorological conditions.

The estimated maximum concentrations of NO_x over one hour were given by Gelhaus (1980) as 687 ug/m^3 for a 600 MW plant and 1374 ug/m^3 for a 1200 MW plant. If the maximum concentrations predicted in this document persist for 45 min., violations of Montana's ambient 1-hour standard for NO_x of 564 ug/m^3 would be violated for both the 600 MW and 1200 MW. Using Gelhaus' predictions, violations also occur for the 600 and 1200 MW plant, although the duration of fumigation is not known. There are no ambient standards for particulates for a period less than 24 hours.

Experiments on effects of NO_x on vegetation were available for exposures of 4 hours or more. As stated earlier, it is difficult to relate these data to lhigh level short-term exposures. The lowest threshold limit of no damage by NO_x was 0.5 ppm (960 ug/m^3) for 4 hours for blue gramma grass (Tingely, et al., 1978). The estimated concentrations here would be below this threshold limit.

1.4.3 Trace Element Deposition

The predicted ambient particulate concentrations meet the U.S. and Montana ambient air quality standards as shown in Table 1.4-2. Further analyses were conducted using the methods of Dvorak, et al. (1977) to assess possible long-term impacts associated with the deposition of trace elements and their subsequent accumulation within the food chain. The predicted increased concentrations in the soil during a 30-year period represent less than 0.2 percent of the background concentration. The predicted increases in the aerial portions of the plants are below reported toxic levels (Dvorak, et al., 1977). The increased trace element concentration in the vegetation of lead, cadmium, arsenic, and selenium would be 2.4 percent or less of the background concentrations in the plants as measured in samples taken in the Poplar River Basin in 1977.

1.4.4 Acidification of Soils

Acidification of soils can be caused by the deposition of sulfuric and nitric acid in precipitation (acid rain) and the formation of H_2SO_4 in the soil following dry deposition of SO_2. The potential for acidification of soils was assessed by estimating the amount of SO_2 deposited in a given area using two different approaches. The highest estimate of elemental sulfur deposition is 51 kg S/ha/yr for a 1200 MW power plant assuming that 60 percent of the sulfur is deposited within a 40 km radius and that there are no SO_2 controls.

Sulfur is an essential nutrient. Maintenance of medium to high crop yields can require between 10 and 40 kg/ha/yr (Noggle and Jones, 1979). In addition some sulfur is removed by cropping following plant uptake, by leaching of soluble sulfates, and by surface drainage. The effect of acid deposition depends partly on the soil type. Impacts are minimized in calcareous soils (Nyborg, 1978). The average calcium content of the Poplar River soils is estimated to be 4 percent (calcium equivalent on a weight basis) (Smetana 1979). Due to the buffering capacity of the soil, using the estimate of 51 kg S/ha/yr and converting the total amount to H_2SO_4 did not result in a change in the soil pH. Wet deposition of sulfur is estimated to be less than the dry deposition rates because of the limited precipitation in the basin and the low ambient concentrations. Thus, acidification of soils is not considered likely in the Poplar Basin.

1.4.5 Other Air Quality Impacts

Health effects can result from increased levels of atmospheric pollutants. A study by Shy (1978) indicated health problems when SO_2 concentrations exceed 250 ug/m^3 for a 24-hour average and 100 ug/m^3 for an annual average. Based on maximum predicted SO_2 concentrations for a 1200 MW plant with no SO_2 controls of 92 ug/m^3 for a 24-hour average and 4.8 ug/m^3 for an annual average, no health problems are expected.

Visibility impacts can be of the short-range type or plume blight and the long-range type or regional haziness. Plume blight, when the plume is visible due to its coloration, is usually caused by NO_x emissions. This could happen under stable, light wind meteorological conditions. Regional haziness is caused by the formation of sulfate aerosol. This occurs slowly so effects are noticeable at distances greater than 100 km which would be outside of the Poplar River Basin.

1.5 Socioeconomic Impacts

1.5.1 Socioeconomic Setting

Daniels and Roosevelt Counties had low population densities and a stable population of 3,100 and 10,300 people, respectively, between 1970 and 1975. Small increases in population are projected for both counties by the year 2000. The population of the Fort Peck Indian Reservation was 9,898 in 1970 of which 34 percent or 3,406 were Indians. By 1973 the Indian population had increased to 6,202.

The area's economy is dominated by agriculture. Daniels County ranked third in production of spring wheat and fourth in durum wheat in Montana for 1975. Roosevelt County was first in number of acres of spring wheat harvested and third in overall wheat production in Montana. Other crops grown in the two counties are barley, oats, flax seed, winter wheat, alfalfa and other kinds of hay, safflower, rye, corn, sunflower, and mustard. Major crops grown on irrigated soil include wheat, alfalfa, barley, oats, and hay. Livestock production in the two counties includes beef and dairy cattle, sheep, hogs, and chickens. There are no other major large industries in the two counties. A potash plant may be developed near Scobey causing an estimated increase in population of about 300 people.

1.5.2 Impact of Flow Apportionment

The proposed apportionment would affect the quantity of water available for irrigation and the suitability of the water for growing crops. At present the number of irrigated acres is small. However, as discussed earlier, the number of irrigated acreage is projected to increase from a total of 4,841 acres in 1975 to 16,286 acres in 1985, and to 29,555 acres by the year 2000. The large expansion is due to the anticipated construction of two reservoirs on the Fork Peck Indian Reservation which would supply 10,000 acres in 1985 and 20,000 acres in the year 2000. The definition of irrigated acres varies by sources of data and thus, so does the reported number of irrigated acres. The acreage figures given above were developed by the IPRWQB and were used to compute the irrigation requirements for the river model.

The impacts due to apportionment were estimated by projecting the change in farm proprietor and total income. The projection for 1985 and 2000 assumed that the two reservoirs mentioned above had been constructed. Change in net income due to the change from irrigated farming to dryland farming was estimated as $50 per acre (Luft, 1979). The number of acres which could be irrigated under Apportionment VI was estimated based on acreage irrigable with mean August flows after apportionment and with three 300 MW units operating in 1985 and with four 300 MW units operating in the year 2000. Decreased crop yields due to poorer water quality were accounted for separately and the combined changes in income computed.

Actual impacts on crops depend on rainfall, water quality in the irrigation water, sensitivity of the specific crops to boron and other salts, and farming practices (e.g. amount of extra water applied to leach the soil of salts). Income changes are illustrated for median rainfall and water quality conditions. Further loss of income could occur in dry years when less water is available for leaching. The change in income due to apportionment is based on the difference between the projected irrigated acreage and the acreage that can be irrigated with mean flows in August. The estimated effects on farm and total personal income are shown in Table 1.5-1. A pessimistic projection was made to show the change in income if the irrigated acreage had to be dryland farmed. This would cause up to a 2.2 percent decrease in farm proprietor's income by the year 2000 in Daniels County and up to a 7.2 percent decrease in Roosevelt County.

It should be pointed out that while the effects on total county income are not large, the direct impacts will be felt primarily by a small number of farms along the Poplar River using the water for irrigation. For these farms the reduction in income is very significant.

Table 1.5-1

IMPACTS OF APPORTIONMENT AND WATER QUALITY ON PERSONAL INCOME IN DANIELS AND ROOSEVELT COUNTIES

(Dollar Figures are in Thousands of 1975 Dollars)

County and Year	Change in Farm Income	Change in Induced Income in County	Total Change in Personal Income	Impact as Percent of Personal Income
Daniels				
1975	$-108	$ -5.1	$ -113.1	-0.4%
1985	-153	-7.2	-160.2	-0.6%
2000	-241	-11.4	-252.7	-1.0%
Roosevelt				
2000*	-684.7	-32.3	-717	-1.2%

---

*No crop yield changes are predicted for 1975 and 1985 median conditions and all acreage can be irrigated in August, thus no income decreases are predicted. Actual income in 1985 is projected to increase if additional acreage is irrigated after construction of the two proposed reservoirs.

The apportionment could affect grazing lands along the river in Daniels County due to less sub-irrigation and reduced spring flooding. If the carrying capacity of the land was reduced from 1400 animal units for G2B grazing land to 1050 animal units for G3 grazing land, a loss of 350 animal units would result. This is approximately 3 percent of the total animal unit capacity in the county. The impact on individual farm proprietors could be significant.

An estimate was also made of the effects of the changes in irrigated land on assessed land values and tax revenues. The maximum impact is based on the difference in irrigated acres in the year 2000. The estimated decrease in assessed values is $15,781 in Daniels County and $97,638 in Roosevelt County. The change in total assessed value is 0.1 percent or less in both counties. This would cause an estimated decrease in tax receipts of $923 in Daniels County and $5,175 in Roosevelt County for a per capita change of 27 cents and 45 cents, respectively.

1.5.3 Other Impacts

An estimate of direct and secondary impacts from the construction of the power plant was made. Based on a construction work force of 450 direct spending in Daniels County was estimated as $200,000. The estimate of secondary spending retained in Daniels County is $16,000 per year. As much as $53,000 is estimated as secondary spending in Roosevelt County due to wholesale and retail trade, although the method used (Chalmers, *et al.*, 1977) may overestimate the spending because of the distance from Scobey in Daniels County to Wolf Point in Roosevelt County. The increased spending by the construction workers was estimated as 0.3 and 0.1 percent of personal income in 1975 for Daniels and Roosevelt counties, respectively. These changes are insignificant when compared to fluctuations caused by changes in the prices for crops received by farmers.

2. PURPOSE AND NEED

In 1972, Saskatchewan Power Corporation (SPC) submitted an application to the Saskatchewan Government for water rights on the Poplar River, a river which crosses the International Boundary in Eastern Montana. Following the issuance of water rights in 1974, SPC formally proposed the construction of a steam electric generating station on the East Fork of the Poplar River, about four miles north of the International Boundary. The generating complex also included a reservoir on the East Fork to be used as a once-through cooling water source and a lignite coal mine near the site. On 29 April 1975, SPC was authorized by the Canadian Government to construct the power plant works, including dam and reservoir, subject to compliance with future water apportionment agreements between the U.S. and Canada. The location of the Poplar River Basin and mine and power plant site are shown in Figures 2.1-1 and 2.1-2. The original design called for four 300 MW units. Present plans are for two 300 MW units. The first unit is completed. Construction of the second unit has started. The unit is scheduled to come on line in 1982. Mining of the lignite in the Hart coal seam was begun in the summer of 1979. The power plant will use approximately 12,335 m^3 of coal per day for each 300 MW unit. The economic life of the plant is 35 years. Other ancillary facilities at the site include a coal handling plant, water treatment facilities and ash disposal lagoons. The plans for operation of the ash lagoons have changed from the original design which called for discharge of the decant to Cookson Reservoir. The ash lagoons will now be lined with a compacted clay layer to limit seepage. The decant will be recirculated. The source of cooling water for the power plant is Cookson Reservoir, a 1600-acre impoundment, on the East Fork of the Poplar River and Girard Creek. Morrison Dam at the lower end of the reservoir was completed in late 1976. After the spring runoff of 1979 the reservoir had filled completely to the level of 753 m. Because the power plant operations and reservoir will result in consumptive water use and will modify the natural transboundary flow of the Poplar River, a flow apportionment agreement is needed between the U.S. and Canada.

The Poplar River Basin is under the jurisdiction of the International Joint Commission (IJC).

The International Joint Commission (IJC) was created by the Boundary Waters Treaty of 1909. The Treaty was enacted to review questions or disputes on the use of boundary waters and other issues. The IJC is a bilateral body composed of three commissioners each from the United States and Canada.

In responding to the planned Canadian development on the East Fork of the Poplar River, the IJC requested, on 8 April 1975, its International Souris-Red Rivers Engineering Board to conduct a study of flow apportionment in the Poplar River Basin. The Board then appointed the Poplar River Task Force to carry out the apportionment studies.

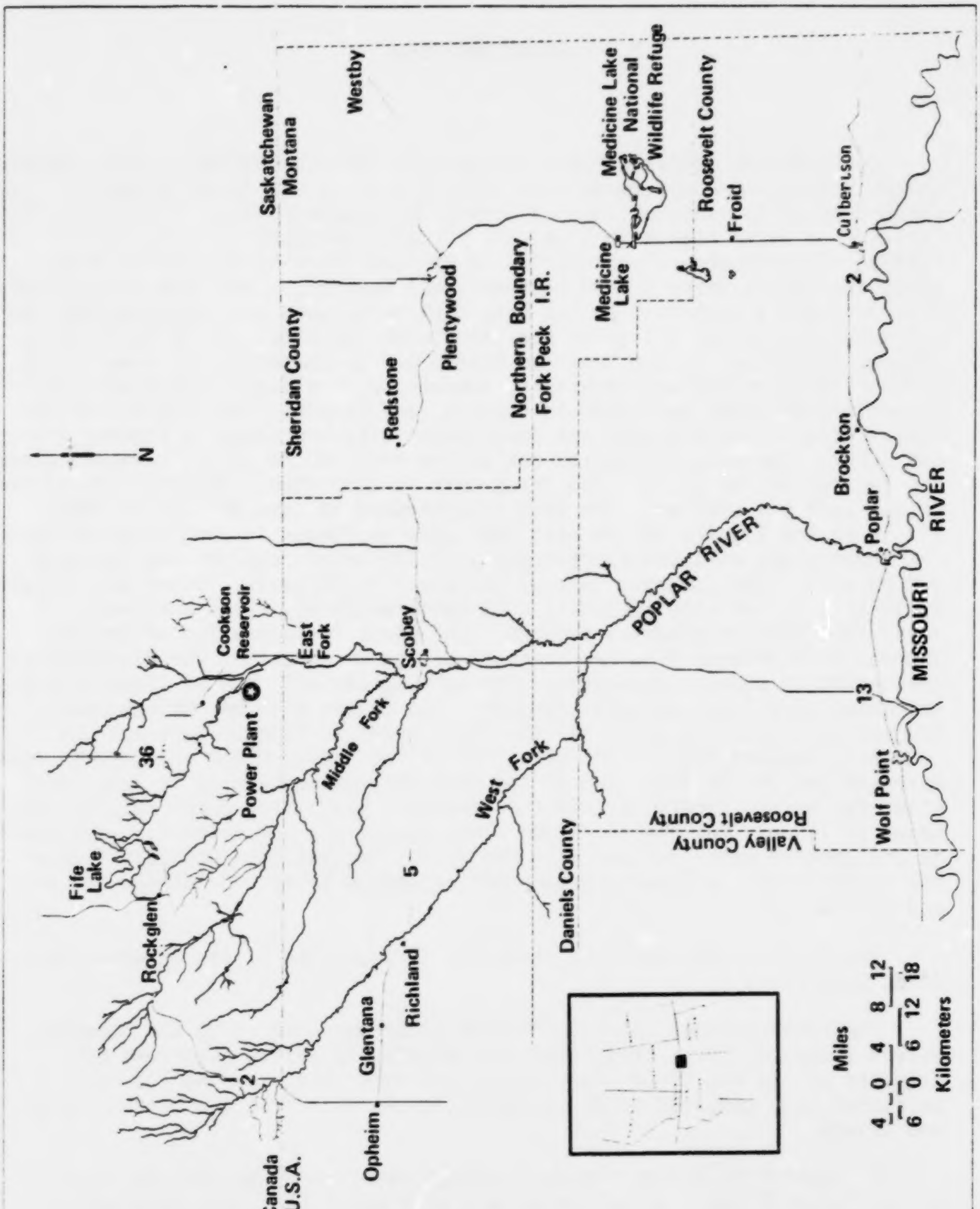

N
Canada
U.S.A.
Saskatchewan
Montana
Opheim
Glentana
Richland
Rockglen
Fife Lake
Power Plant
Cookson Reservoir
East Fork
Middle Fork
West Fork
Scobey
Sheridan County
Redstone
Plentywood
Westby
Northern Boundary
Fork Peck I.R.
Medicine Lake
Medicine Lake National Wildlife Refuge
Roosevelt County
Froid
Culbertson
Daniels County
Valley County
Roosevelt County
POPLAR RIVER
Poplar
Brockton
Wolf Point
MISSOURI
RIVER
2
36
5
13
2
Miles
4 0 4 8 12
6 0 6 12 18
Kilometers

Figure 2.1-1 LOCATION OF THE POPLAR RIVER BASIN

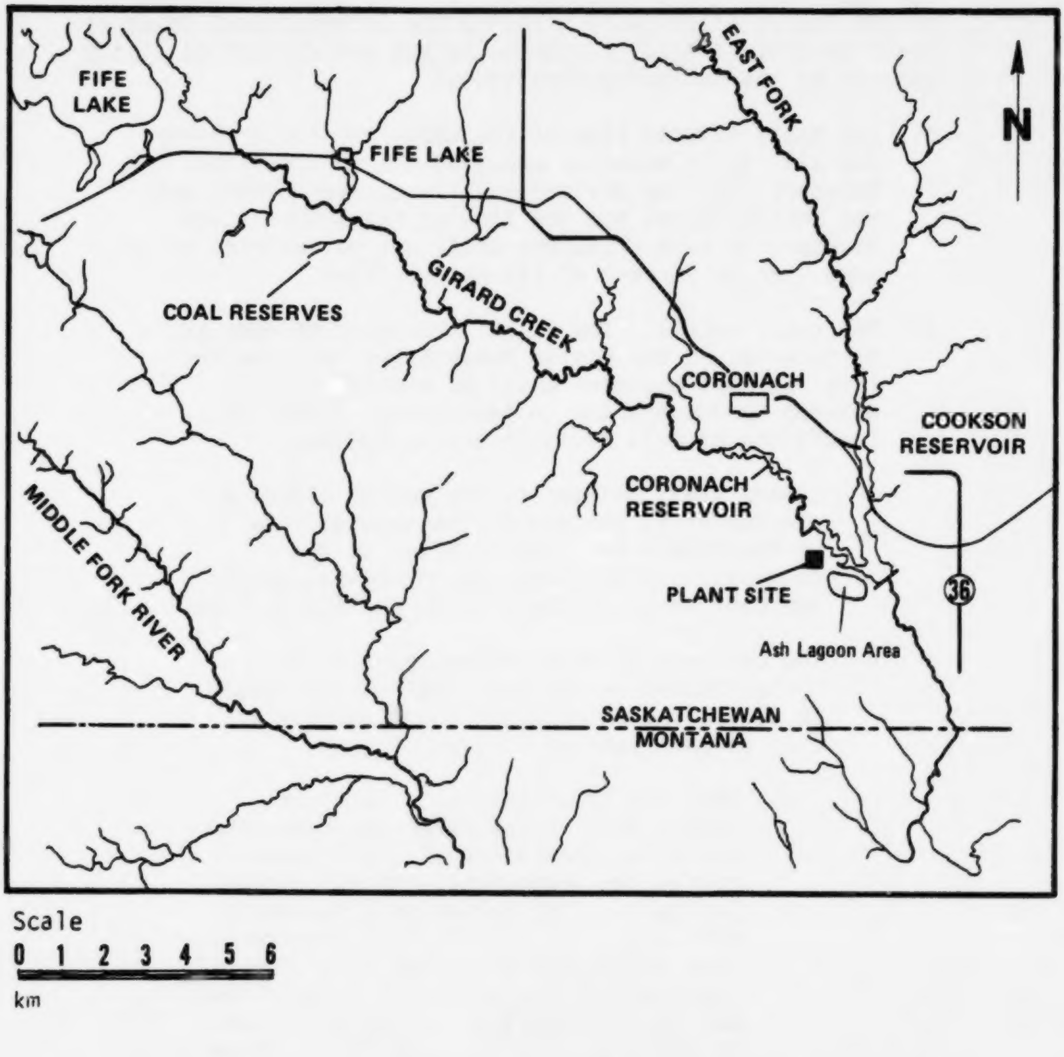

FIFE LAKE
FIFE LAKE
EAST FORK
N
COAL RESERVES
GIRARD CREEK
CORONACH
COOKSON RESERVOIR
CORONACH RESERVOIR
PLANT SITE
36
Ash Lagoon Area
MIDDLE FORK RIVER
SASKATCHEWAN
MONTANA
Scale
0 1 2 3 4 5 6
km

Figure 2.1-2 LOCATION OF POPLAR RIVER POWER PLANT SITE

The Task Forces' recommendations for flow apportionment in the Poplar River Basin were endorsed by the IJC and were published in a 1978 report entitled, "Water Apportionment in the Poplar River Basin." The recommended apportionment essentially involves an equal division of transboundary flows between the U.S. and Canada. The following is a direct transcript of the Board's recommended apportionment which will subsequently be referred to as Apportionment VI in this document.

> "The aggregate natural flow of all streams and tributaries in the Poplar River Basin crossing the International Boundary shall be divided equally between Canada and the United States subject to the following conditions:
>
> 1. The total natural flow of the West Fork Poplar River and all its tributaries crossing the International Boundary shall be divided equally between Canada and the United States but the flow at the International Boundary in each tributary shall not be depleted by more than 60 percent of its natural flow.
>
> 2. The total natural flow of all remaining streams and tributaries in the Poplar River Basin crossing the International Boundary shall be divided equally between Canada and the United States. Specific conditions of this division are as follows:
>
>   a) Canada shall deliver to the United States a minimum of 60 percent of the natural flow of the Middle Fork Poplar River at the International Boundary, as determined below the confluence of Goose Creek and Middle Fork.
>
>   b) The delivery of water from Canada to the United States on the East Poplar River shall be determined on or about the first day of June of each year as follows:
>
>   i) When the total natural flow of the Middle Fork Poplar River, as determined below the confluence of Goose Creek, during the immediately preceding March 1st to May 31st period does not exceed 4690 cubic decameters (3800 acre-feet), then a continuous minimum flow of 0.028 cubic meters per second (1.0 cubic feet per second) shall be delivered to the United States on the East Poplar River at the International Boundary throughout the succeeding 12 month period commencing June 1st. In addition a volume of 370 cubic decameters (300 acre-feet) shall be delivered to the United States upon demand at any time during the 12 month period commencing June 1st.

ii) When the total natural flow of the Middle Fork Poplar River, as determined below the confluence of Goose Creek, during the immediately preceding March 1st to May 31st period is greater than 4690 cubic decameters (3800 acre-feet), but does not exceed 9250 cubic decameters (7500 acre-feet) then a continuous minimum flow of 0.057 cubic meters per second (2.0 cubic feet per second) shall be delivered to the United States on the East Poplar River at the International Boundary during the succeeding period June 1st through August 31st. A minimum delivery of 0.028 cubic meters per second (1.0 cubic feet per second) shall then be maintained from September 1st through to May 31st of the following year. In addition, a volume of 617 cubic decameters (500 acre-feet) shall be delivered to the United States upon demand at any time during the 12 month period commencing June 1st.

iii) When the total natural flow of the Middle Fork Poplar River, as determined below the confluence of Goose Creek, during the immediately preceding March 1st to May 31st period is greater than 9250 cubic decameters (7500 acre-feet), but does not exceed 14,800 cubic decameters (12,000 acre-feet), then a continuous minimum flow of 0.085 cubic meters per second (3.0 cubic feet per second) shall be delivered to the United States on the East Poplar River at the International Boundary during the succeeding period June 1st through August 31st. A minimum delivery of 0.057 cubic meters per second (2.0 cubic feet per second) shall then be maintained from September 1st through to May 31st of the following year. In addition, a volume of 617 cubic decameters (500 acre-feet) shall be delivered to the United States upon demand at any time during the 12 month period commencing June 1st.

iv) When the total natural flow of the Middle Fork Poplar, as determined below the confluence of Goose Creek, during the immediately preceding March 1st to May 31st period exceeds 14,800 cubic decameters (12,000 acre-feet) then a continuous minimum flow of 0.085 cubic meters per second (3.0 cubic feet per second) shall be delivered to the United States on the East Poplar River at the International Boundary during the succeeding period June 1st through August 31st. A minimum delivery of 0.057 cubic meters per second (2.0 cubic feet per second) shall then be maintained from September 1st through to May 31st of the following year. In addition, a volume of 1,230 cubic decameters (1,000 acre-feet) shall be delivered to the United States upon demand at any time during the 12 month period commencing June 1st.

c) The natural flow at the International Boundary in each of the remaining individual tributaries shall not be depleted by more than 60 percent of its natural flow.

3. The natural flow and division periods for apportionment purposes shall be determined, unless otherwise specified, for periods of time commensurate with the uses and requirements of both countries."

In August, 1977, the IJC was asked to study present water quality and water uses and to identify any effects on water quality of flow apportionment, the SPC power plant, reservoir and associated development, and other possible developments in the basin. The IJC was also asked to recommend measures to ensure that Article IV of the Boundary Waters Treaty of 1909 would be honored. This provision states that the boundary waters "shall not be polluted on either side to the injury of health or property on the other." The study of the water quality impacts of the power plant was done by the Poplar River Water Quality Board. The results were first published by the IJC in 1979 in a report titled "International Poplar River Water Quality Study." The IJC held public hearings on this report at Scobey, Montana and Coronach, Saskatchewan in September, 1979. The IJC has reviewed the Board report and hearings and issued its final report including recommendations in January 1981.

The IJC made several recommendations to ensure compliance with Article IV of the Boundary Waters Treaty. These include numerical objectives for total dissolved solids and boron concentrations in the East Fork at the International Boundary and setting up a bilateral claims commission.

The recommendations will go to the Canadian desk at the U.S. State Department and the Canadian Department of External Affairs. The U.S. EPA has a liaison person working with the State Department and the IJC. A joint U.S.-Canadian water quality monitoring program is being developed by the State of Montana, the U.S. State Department and Canada. Preliminary discussions are also being held between the U.S. and Canada about the potential for negotiating an Air Quality Treaty.

Since the SPC power plant is being constructed outside of the U.S. boundaries, there is no direct obligation for the preparation of an Environmental Impact Statement (EIS). However, a federal action is required for the U.S. Government to enter into a flow apportionment agreement with Canada. Therefore, an EIS is required by NEPA prior to such an agreement. The environmental statement analyzes the integrated impacts of power plant and reservoir operation and flow apportionment on the Poplar River Basin and associated areas within the U.S. Changes in water quantity and quality and air quality are evaluated and the resulting socioeconomic and biological impacts assessed. It is designed to meet NEPA requirements associated with the final acceptance of a flow apportionment agreement between the governments of the U.S. and Canada.

Another legal concern is the status of Indian water rights. The Sioux and Assiniboine Tribes of the Fort Peck Indian Reservation claim rights to all the water of the Poplar River which they can use based on the treaty which established the Fort Peck Indian Reservation. The tribe states that the Winters vs. United States case in the U.S. Supreme Court applies here and confirms that no limit on future uses of water was included by the original treaty. This claim is not analyzed in this document. Rather, the impacts of flow apportionment on the Fort Peck Indian Reservation are based on the projected water uses including the proposed irrigation project and whether flow and quality of the Poplar River are adequate to meet the projected demands.

3. ALTERNATIVES INCLUDING THE PROPOSED ACTION

3.1 ATMOSPHERIC EMISSIONS AND CONTROL

Present plans for operation of the first 300 MW unit of the SPC Power Plant include operation with zero percent SO_2 control (i.e., no flue gas desulfurization equipment). The unit will operate at a particulate control rate of 99.5 percent by the use of electrostatic precipitators.

The operating permit for the first 300 MW unit issued to SPC by the Department of Environment Saskatchewan specifies that ambient air quality standards set by the Saskatchewan Air Quality Act must be met. Monitoring of ambient air quality must be done continuously at three sites along with in-stack sampling. Whether air quality controls are required for subsequent units will depend on the results of the monitoring program for the first unit. If Saskatchewan standards are violated, SPC must develop and implement a mitigation plan. Power plant emission standards in Saskatchewan are expected in the next several years and may influence emission levels of future units.

Analysis of air quality impacts must consider ambient air quality standards, the prevention of significant deterioration (PSD) requirements for Class I and II areas, and the concentrations during fumigation events. Each of these areas is discussed and the effect of air quality control options outlined. The impact analyses in Section 5.1 indicate that there will be no violations of ambient Montana or U.S. air quality standards with up to four 300 MW units with no SO_2 controls. The highest predicted SO_2 concentrations will occur during atmospheric inversions which result in plume fumigations as are discussed in a later section. The highest mean annual increases above background SO_2 concentrations are predicted by the CRSTER model to occur along the 120° to 170° azimuths (generally southeast) from the plant site; predicted SO_2 concentrations, even at locations near the International Boundary, are well below standards (Table 3.1-1). Moreover, the predicted ambient maximum concentrations and duration of exposures are also below acute and chronic threshold limits for the most sensitive plant species. Therefore, although the SPC power plant will result in elevated concentrations of SO_2, there are no projected impacts on terrestrial ecosystems or human health in the area due to the increased ambient concentrations.

The effects of flue gas desulfurization (FGD) are also considered. Current FGD systems are capable of SO_2 control ranging from about 60 to over 90 percent reduction. Therefore, the alternatives of 60 and 90 percent SO_2 control were considered. Table 3.1-2 illustrates the effects of SO_2 stack controls and number of operating units on ambient SO_2 concentrations. When the maximum allowable increases for Class II areas are compared with predicted increases resulting from the Poplar River plant, the maximum values with four operating units and zero

Table 3.1-1

ESTIMATED MAXIMUM POLLUTANT CONCENTRATIONS IN MONTANA FROM THE POPLAR RIVER POWER PLANT

(Concentrations in micrograms per cubic meter)[a]

Pollutant	Time Period	Power Plant Size		NAAQS[b]	Montana AAQS	PSD Class II	MCD[c]	Sask[d] AAQS
		600 Mw	1200 Mw					
Sulfur Dioxide	1-hour	400 (214)[e]	800 (428)	--	1300	--	450	450
	3-hour	166 (96)	332 (192)	1300	--	512	--	--
	24-hour	46 (28)	92 (56)	365	265	91	150	150
	Annual	1.6 (2.4)	3.2 (4.8)	80	55	20	30	30
Nitrogen Oxides	1-hour	134 (74)	268 (148)	--	564	--	--	400
	Annual	0.6 (.79)	1.2 (1.6)	100	94	--	60	100
Particulates	24-hour	2.0 (2.6)	4.0 (5.2)	150[f]	200	37	--	120
	Annual	0.06 (.2)	0.12 (.4)	60[f]	75	19	60	70

[a] Note - higher concentrations have been predicted using a fumigation model. However, the duration time remains uncertain. SO_2 concentrations assume zero percent control; particulate concentrations assume 99 percent control.

[b] National Ambient Air Quality Standards

[c] Maximum Canadian Desirable Criteria

[d] Saskatchewan Ambient Air Quality Standards

[e] Numbers in parentheses are predicted concentrations in this document

[f] Secondary Standard

Table 3.1-2

MAXIMUM SO_2 CONCENTRATIONS IN THE U.S. EXPRESSED AS A PERCENTAGE OF THE MAXIMUM ALLOWABLE INCREASE (PSD) IN CLASS II AREAS

Level of Control		Number of Units	
		Two	Four
0 percent	3-hour	18.7	37.5
	annual	12.0	24.0
60 percent	3-hour	7.5	15.0
	annual	4.8	9.6
90 percent	3-hour	1.9	3.8
	annual	1.2	2.4

These values are based on air quality modeling results of the EPA.

percent SO_2 control represent only about 3 percent and 24 percent of the 3-hour and annual allowable values, respectively.

A similar comparison may be made for particulate emissions. At a 99 percent level control using electrostatic precipitators (ESP), the maximum values are only 14.0 percent and 2.1 percent of the maximum allowable (PSD) 24-hour and annual increases, respectively. These percentages would be reduced to 7 and 1 percent with the use of 99.5 percent ESP's (as planned). It should be emphasized that the preceding discussion has considered the maximum constituent concentrations ocurring near the International Boundary. The predicted maximum concentrations occurring in most of the U.S. part of the Poplar River Basin are much less than those near the boundary. For example, maximum SO_2 concentrations predicted for most of Daniels County are about an order of magnitude (ten times) less than those occurring near the border. Therefore, the relationship of predicted ambient concentrations to maximum allowable increases is considerably more divergent in most of Daniels County than is indicated by the preceding comparisons at locations near the border.

The potential for morning fumigation events is quite high in the Poplar River Basin. The predicted ground-level concentrations of SO_2 under very stable meteorological conditions are above the lowest threshold limit for sensitive species. The 1-hour SO_2 standard can be exceeded during fumigation with two units between 6 and 10 km from the site and very stable meteorological conditions. However, the Montana standard specifies that the concentration must be exceeded in four consecutive days. It is unlikely that fumigation events would occur this often at a given location. Although no adverse impacts on terrestrial vegetation due to fumigation are predicted due to the short duration and isolated spatial occurrences, the projected SO_2 concentrations during fumigation would be reduced to below threshold limits with the addition of FGD equipment.

The CRSTER model results were used to determine whether violations of the Class I PSD regulations could occur at the presently designated Class I area, the Medicine Lake Wildlife Refuge and the Fort Peck Indian Reservation, which may be designated a Class I area in the future. The Medicine Lake National Wildlife Refuge is a Class I area located approximately 105 km (65 miles) downwind from the power plant site. This distance is beyond the reliable predictive limits of the CRSTER model; however, the potential impacts of atmospheric emissions must be considered due to the very limited concentration increases allowed based on PSD regulations (1977 Clean Air Act). The northern boundary of the Fort Peck Indian Reservation is directly south of the power plant site at a distance of approximately 48 km (30 miles).

With 99.5 percent control on four 300 MW units, the particulate concentrations from Gelhaus (1980) and this document at a downwind distance of 48 km (the limit of modeling results) for the maximum 24-hour and annual mean concentrations are well below the PSD values of 5 and 10 ug/m^3 for the corresponding exposure times (Table 3.1-3). With 99 percent control, the predicted concentration at 30 miles downwind would be twice the 99.5 percent values, and would therefore remain below the

Table 3.1-3

PREDICTED MAXIMUM PARTICULATE CONCENTRATION AT THE FORT PECK INDIAN RESERVATION BOUNDARY

Time Period	PSD Class I Increment	Power Plant Size					
		300 MW		600 MW		1200MW	
		A	B	A	B	A	B
24 Hour	10	0.46	0.4	0.92	0.8	1.84	1.6
Annual	5	0.02	0.04	0.04	0.08	0.08	0.16

Note: All values are in μg/m^3 with 99 percent control. Values under A are from Gelhaus, 1980. Values under B are from EIS.

Class I PSD values. Moreover, dispersion effects in the next 56 km to the Medicine Lake Refuge would result in considerable further reduction in the particulate concentrations.

The predicted maximum SO_2 concentrations for two power plant units (zero percent control) at the modeled distance limits (48 km) equal or exceed the Class I PSD regulations for annual 24-hour and 3-hour averages (Table 3.1-4). These levels would result in violations within the proposed Class I area. Extrapolation of the modeled diffusion rate indicates that ambient increases in SO_2 concentrations at the refuge would be below PSD regulation values for two 300 MW units. As indicated in Table 3.1-2, Gelhaus' results predict that greater than 60 percent SO_2 control would be needed to meet the Class I PSD values at a distance of 48 km.

The operation of four 300 MW units without FGD would result in predicted maximal 24-hour SO_2 concentration increases of between 20 and 44 ug/m^3 at a distance of 48 km (Table 3.1-4). Such increases above ambient levels are about four times the Class I PSD values, and, based on the approximate predicted diffusion rate for 24-hour concentrations beyond the 48 km modeling distance, they would remain slightly above the PSD values (7.1 ug/m^3) at the 105 km distance to the refuge. Using the same approach for annual or 3-hour values would result in predicted concentrations below the allowable limits. Operation of four 300 MW units with at least 60 percent FGD systems would result in predicted concentrations below the maximum allowable increases at the Medicine Lake Refuge. Although the previous approximate calculations result in a potential for a 24-hour SO_2 violation (with four units and zero percent control) of the PSD regulations for the Medicine Lake Wildlife Refuge, the actual probability for such an occurrence is extremely low due to the nature of the modeling methodology. The predictive value of a Gaussian Plume model such as CRSTER is quite low at distances beyond 40 to 48 km from the source. The resultant concentrations at the distance limits of the model should be considered very conservative (i.e., they are probably much higher than the actual concentrations under normal meteorological conditions). This is especially true under stable conditions. The conservative nature of the predicted SO_2 concentrations is further enhanced when the limits are extended to 105 km.

The CRSTER modeling results indicate a possibility of contravention of Class I PSD regulations in the northern portion of the Fort Peck Indian Reservation, which is a potential Class I area. As indicated in Table 3.1-4, the operation of four units with 60 percent control could result in the violation of the 3-hour and 24-hour standard. All the Class I standards could be met if the SO_2 control was increased to 90 percent.

Table 3.1-4

PREDICTED MAXIMUM SO_2 CONCENTRATIONS AT THE FORT PECK INDIAN RESERVATION BOUNDARY

Time Period	Allowable PSD Increment Class I	300 MW[a]						600 MW[a]						1200 MW[a]					
		Percent Control						Percent Control						Percent Control					
		0		60		90		0		60		90		0		60		90	
		A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B
3 Hour	25	49	12.5	20	5	5	1.2	98	25	39	10	9.8	2.5	196	50	78	20	2.0	5
24 Hour	5	11	5	4.4	1.8	1.1	0.5	22	10	8.8	4	2.2	1	44	20	17.6	8	4.4	2
Annual	2	0.4	0.5	0.16	0.2	0.04	0.05	0.8	1	0.3	0.4	0.08	0.01	1.6	2	0.6	0.8	0.2	0.2

Note: All values are in ug/m^3. Values under A are from Gelhaus, 1980. The values under A for 60 and 90 percent control are calculated values. Values under B are from Chapter 5 of this document.

[a] Power plant size

3.2 FLOW RELATED ALTERNATIVES

3.2.1 Alternative Flow Apportionments

Twenty-two alternative apportionments were considered by the Poplar River Task Force. These were narrowed down to four alternatives by the EPA for analysis in the EIS. The flow apportionment alternatives analyzed are shown in Table 1.2-1. Three basic apportionment divisions of the total natural flow of the Poplar River at the International Border between the U.S. and Canada were considered. These are a 50:50 division between the two countries with no restrictions on flow reduction in a given fork of the Poplar River, a 50:50 division with various restrictions on maximum flow reductions, and a division stating that 70 percent of the flow could be used by Canada and 30 percent would pass to the U.S. There were five different sets of flow reduction restrictions evaluated in the EIS. These are shown as Apportionment IIIa and b, IVa and b, and VI in Table 1.2-1. Apportionment VI is the one recommended by the IJC (1978). This case is used to analyze impacts on agriculture, water supplies, and biota in Chapter 5 of the EIS. In this chapter the flows under the alternative apportionments are compared to the flows under Apportionment VI.

The no-action case, i.e., no apportionment, would allow Canada to use all of the flow within the Canadian part of the basin to estimate the worst case conditions. The scenarios (4 to 6) were run with 1975, 1985, and 2000 levels of development in the U.S. These model scenarios did not include the Cookson Reservoir or the SPC power plant. Another scenario (3) could be considered a no-action case in that it was based on the 1975 level of development with the Cookson Reservoir but not the SPC power plant.

The major differences between the apportionment alternatives are reflected in the predicted flows on the Middle and West Forks of the Poplar River. The flows on the East Fork are the same for Apportionments IVa, IVb, V, and VI. Flows on the East Fork would be made up of a continuous release from the Cookson Reservoir of 1 to 3 cfs and additional scheduled releases. The scheduled releases to the East Fork under Apportionment VI would be between 300 and 1,000 ac-ft distributed throughout the irrigation season (Table 1.2-2). Apportionment IIIa and IIIb would provide 30 to 50 percent of the flow in the East Fork. However, these scenarios did not include the Cookson Reservoir or the SPC power plant and so are not realistic. Under Apportionment VI flows would be up to 50 percent of the natural flow on the West Fork and up to 60 percent of the natural flow on the Middle Fork. Flows on the Middle Fork would be 60 percent of the natural flow under Apportionment IVa and would be 40 percent under Apportionment IVb. Flows on the West Fork and tributary would be 40 percent of the natural flow under Apportionment IVa and 60 percent under Apportionment IVb.

The flows predicted in the critical months will be compared. March is important for livestock, fish and wildlife, and spreader irrigation.

June through September is the primary irrigation season. The Middle Fork is important for fish habitat. None of the apportionments provide enough water for all projected U.S. demands to be met. Demands for spreader irrigation in March can be met at both the Middle and West Forks under Apportionments IVa and VI through the year 2000. Median flows on the West Fork are about 57 ac-ft less under Apportionment IVa than under Apportionment VI. Peak flows are about 16 ac-ft lower under Apportionment IVa than under Apportionment VI. Median and peak flows on the Middle Fork are slightly higher under Apportionment VI. Flows are lowest on both the Middle and West Forks under Apportionment V.

June flows (Table 3.2-1) are the same for all alternative apportionments under low flow conditions. Lowest median and peak flows occur under Apportionment V. Median flows in 1975 are highest for Apportionment IVa and VI. In the year 2000, with four 300 MW units operating, the flows are 8.1 ac-ft higher under Apportionment IV. Peak flows are 24.3 ac-ft higher under Apportionment IVa in 1975 and 2000. Water demands cannot be met under low flow conditions on the Middle Fork under any of the apportionments in 1975 or 2000 or on the West Fork in 2000.

Summer peak flows on the Middle Fork are highest under Apportionment IVa than the other cases. Peak flows on the West Fork are highest under Apportionment IVb. Flows for July through September are at very low levels (less than 3.2 ac-ft per month) for the same months. Summer irrigation demands are exceeded for the same months and frequencies for Apportionment IVa and VI. Summer flows are not adequate on either the Middle or West Fork to meet all the irrigation demand. The large decreases in flow on the Middle Fork make Apportionment V and IVb less desirable than VI. Overall, 40 ac-ft more water would be available under median flow conditions under Apportionment VI and IVa for these months. Eight ac-ft more water would be available under low flow conditions under Apportionment IV. In summary, Apportionment VI appears to provide the most flow compared to the other alternatives. The increased flows in March on the Middle Fork under Apportionment IVa would be beneficial to fish and wildlife. However, this would be offset by decreased flows on the West Fork during the irrigation season.

Under Apportionment IVb, flow in the Lower Middle Fork would be slightly less than under Apportionment VI, and full water demands could not be met from June to September for the same percentage of time. Flows in the West Fork would be higher, but full water demands still cannot be met for the same percentage of time from May through September.

Thus, none of the flow apportionment alternatives allow all water demands to be met. Apportionment VI provides the most flow when compared to the other alternatives. The increased March flows in the Lower Middle Fork under Apportionment IVa would be beneficial to fish and wildlife. However, this would be offset by the decreased flows on the West Fork during the irrigation season.

3.2.2 No Action Case

The no-action case under existing 1975 conditions with the Cookson Reservoir and the worst case with no transboundary flows under 1975, 1985, and 2000 levels of development can be compared to historical flows.

Table 3.2-1

JUNE FLOWS UNDER ALTERNATIVE APPORTIONMENTS

Station 7 (Middle Fork)

	1975(1)*				2000(4)			
Frequency**	Ap IVa	Ap IVb	Ap V	Ap VI	Ap IVa	Ap IVb	Ap V	Ap VI
10	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
50	380.7	267.3	210.6	372.6	81.0	24.3	0.0	81.0
90	2681.1	2235.6	2016.9	2608.2	2381.4	1944.0	1717.2	2308.5

Station 11 (West Fork)

	1975(1)				2000(4)			
Frequency	Ap IVa	Ap IVb	Ap V	Ap VI	Ap IVa	Ap IVb	Ap V	Ap VI
10	129.6	129.6	129.6	129.6	0.0	0.0	0.0	0.0
50	421.2	437.4	421.2	429.3	64.8	97.2	64.8	72.9
90	2875.5	3045.6	2818.8	2924.1	2511.0	2721.6	2462.4	2559.6

---

*Number in parentheses indicates the number of 300 MW units operating.

**Percent of time flow is predicted to be less than value shown.

Data are from Karp II model output from Montana Health and Environmental Sciences

As before, flows are compared for March which is important for stock, fish and wildlife, and spreader irrigation and June through September which is the main irrigation season.

Flows under the no-action case (i.e., with Cookson Reservoir but with no flow apportionment or power plant) are discussed first. Flows for the Middle and West Forks are the same as historical conditions. On the East Fork, low flows are higher due to seepage from the reservoir, but spring runoff peak flows are less. For example, in March median flows are about 85 percent less and peak flows are about 46 percent less. In the summer, median flows on the East Fork range from 19 percent less in September to 20 percent more in July. High summer flows were between 35 percent less in June to 39 more in August. A similar pattern occurs on the East Fork at Scobey.

The low flows under existing conditions are adequate to meet municipal, stock, and irrigation demands on the East Fork at Scobey. Irrigation and stock demands can be met on the Middle Fork only in March, April, and May. Stock and irrigation demands can be met on the West Fork for all months except August and September. Stock and irrigation demands on the main Poplar can be met only in April. Water demands on the Main Poplar at Poplar cannot be met in March, July, or August. Under high flow conditions, demands can be met at all stations except the Middle Fork in August and September.

Flows for the worst case with no transboundary flows are compared to historical conditions for the lower portions of the three forks in Table F-3 in the Appendix. Low flows up to 1985 are approximately the same as under historical conditions on the lower Middle and West Forks. By the year 2000, low flows at Scobey would be less than 3.2 ac-ft and low flows on the lower West Fork would be 47 percent less. Median and peak flows in the spring are significantly less, but water requirements could be met. Flows on the Main Poplar below the West Fork are adequate to meet water demands only under high flow conditions. Low flows in the summer are about the same at all stations except on the East Fork at Scobey, which is less than 3.2 ac-ft for the worst no-action cases. Median and high flows in 1975 are between 25 and 50 percent less. By 1985 and 2000, the increased water demands result in flows less than 3.2 ac-ft most of the time for the low and median flow cases. The 1985 and 2000 demands can be met under high flow conditions at all stations in June and July and under 1985 demands in August and September. The months when demands cannot be met are the same for existing conditions, but fewer acres could be irrigated because of the decreased amount of available water.

3.2.3 Demand Releases

The actual impact of the flow apportionments will depend partly on the timing and flow rate (cfs) of the scheduled releases. The schedule used in the model spread the release over the period from May to September as recommended by the Poplar River Task Force:

Month	Percent
May	12
June	18
July	32
August	27
September	11

This division was based on need for irrigation rather than the timing of a specific method of irrigation. However, the average number of irrigation applications in the Poplar Basin was 2.4 with a maximum of 4. One approach to increase the water available for irrigation would be to drop the release in May and increase the releases in July through September when more water is needed. Another consideration is the flow rate - a higher flow rate for a period corresponding to the length of the normal irrigation application would be beneficial to fish and wildlife.

Another approach would be to use the September release amount to mitigate the impact of the apportionment on fish and wildlife. The release could then be made in April of 33 ac-ft. If the release was made in one day, the flow rate would be 16.6 cfs, and, if in two days, the flow rate would be 8.3 cfs. These flow rates are not adequate for maintaining channel morphology but would be a significant addition to the apportionment flows on the East Fork and would increase the flow rate to the recommended flow of 10 cfs.

3.3 WATER QUALITY

Evaluation of alternative transboundary flows, i.e., 70/30 apportionment (V), indicates that the operation of one to four 300 MW units at successive levels of development will have the same effect on water quality at station 1 as the identical sequence of development under the recommended apportionments (scenarios 28 to 32). The predicted boron, TDS and SAR levels at station 1 provided by the water quality simulation model for Apportionment V and the worst case are summarized in Table 3.3-1. These values under median and high flow conditions are the same as those predicted for Apportionment VI. Similar levels of boron, TDS, and SAR are predicted at Scobey and the main stem. The predicted concentrations at these stations are presented in Appendix Tables H-1 through H-9. A detailed discussion of the water quality impacts is given in Section 5.3.

Modeling scenarios 4, 5, and 6 represent the worst case action in terms of apportionment alternatives. Under these conditions Canada would make unlimited use of available water resources. These scenarios do not consider the impacts of either water storage or power plant utilization, and, therefore, represent unlikely alternatives. Based on water quality simulations, scenarios 4, 5, and 6 would result in both the unavailability

Table 3.3-1

Range of Predicted Water Quality for Alternative Apportionments for March through September

Scenario[a]	Percent Probability Level[b]	Boron, mg/l	TDS, mg/l	SAR
Worst-Case				
4	90	-[c]	-	-
	50	2.0-4.4	1103-2279	3.7- 6.1
5	90	-	-	-
	50	2.0-4.9	1127-2536	3.7- 6.4
6	90	-	-	-
	50	2.2-5.5	1207-2853	3.8- 6.6
Apportionment V				
23	90	1.8-2.0	930-1028	11.9-17.1
	50	0.8-0.9	507- 596	4.8- 8.5
24	90	2.2-2.5	1107-1268	13.1-19.7
	50	1.0-1.2	634- 747	5.7-10.6
25	90	2.9-3.7	1459-1967	15.1-22.2
	50	1.3-1.6	816-1003	7.0-12.6
26	90	2.9-3.7	1459-1967	15.1-22.2
	50	1.3-1.6	816-1003	7.0-12.6
27	90	3.8-8.0	2381-4796	16.4-31.2
	50	1.3-2.2	847-1347	6.0-12.8

[a] Refer to Table 1.2-1 for description of the scenarios.

[b] Percent probability means the concentrations are predicted to be less than the value shown the specified percentage of the time.

[c] Dash indicates that flows were too low to make a water quality prediction.

of sufficient supplies and significant deterioration in water quality in the East Fork at the border during the period of March through September. Although SO_4 and SAR levels would be expected to remain within acceptable limits, predicted boron and TDS levels would be high during the period July through September. Water quality would not be degraded on the East Fork at Scobey or further downstream.

3.3.1 Mitigation of Water Quality Impacts

The increased salinities of East Fork waters under the apportionment alternatives are due to mine and power plant related inflows, Fife Lake overflows, and evaporation in Cookson Reservoir. Modifications in the ash settling lagoons have been made to eliminate direct discharge to the reservoir and minimize ground water seepage. This will decrease TDS concentrations in the East Fork at the border by about 10 percent. Boron concentrations will be reduced significantly from a maximum predicted concentration of 9.3 to about 2.1 mg/l. The mitigation measures installed by SPC include recirculation of the ash lagoon discharge instead of discharge to the Cookson Reservoir and compaction of a clay layer as a base for the ash lagoons. These measures are expected to limit total seepage to the East Fork and reservoir to less than 2 l/sec (IJC, 1979). The concentrations in the East Fork could be reduced even further if compaction was extended to a 600 mm layer which would limit seepage to approximately 0.7 l/sec (IJC, 1979). Monitoring of the ash lagoon seepage is required by Saskatchewan Environment. If seepage to Cookson Reservoir exceeds 5 liters per second or seepage to the East Fork exceeds 2 liters per second, SPC must propose mitigation methods (Saskatchewan Environment, 1980).

Mitigation methods to reduce impacts of saline irrigation waters would most likely involve methods to control salts in irrigation return water and salt buildup in soils. These methods are described in Section 5.3.4. A leaching fraction of 0.2 minimizes the impacts of the poor quality irrigation water on crop yields. Increasing the leaching fraction to 0.3 results in only a small improvement in yield which would probably be offset by the loss of acreage which could be irrigated with the available water.

Another approach is to set numerical water quality objectives to be met at the International Border. The IJC has proposed water quality objectives for the period March through October on the East Fork at the International Border. The recommendations are as follows:

- Maximum long-term flow-weighted average concentration of 1000 mg/l TDS
- Maximum flow-weighted concentration for any three consecutive months of 1500 mg/l TDS
- Maximum long-term flow-weighted average boron concentration of 2.5 mg/l

- Maximum flow-weighted average boron concentration during any three consecutive months of 3.5 mg/l.

The model results indicate that these objectives can be met with Apportionment VI and up to two 300 MW units operating. With three units operating, the three month criterion could be violated for both TDS and boron. With four units operating both the long-term and average criteria for TDS and boron could be exceeded.

4. AFFECTED ENVIRONMENT

4.1 LOCATION

The Poplar River basin is located in Southern Saskatchewan (Canada) and Northeastern Montana between 49° 30' and 48° north latitude and 104° 45' and 106° 45' west longitude (Figure 2.1-1). The Poplar River originates in Saskatchewan as three main tributaries: West Fork, Middle Fork and East Fork. A major portion of the Middle and East Forks drainage basins lies in Canada. Both of these streams join to form the main stem of the Poplar River near the town of Scobey, Montana, located approximately 12 miles south of the international boundary. The West Fork sub-basin is located mainly in Montana and joins the Poplar River at a point approximately 37 miles below the U.S.-Canadian boundary.

The Poplar River may be divided into five major segments which will form the basis for subsequent discussions concerning apportionment alternatives and associated flow regimes. In addition to the three aforementioned forks, the main stem of the Poplar River may be divided into a 25-mile segment between the confluence of the East and Middle Forks and the confluence of the West Fork and a 40-mile segment between the West Fork confluence and the Missouri River.

Three small transboundary tributaries originate in Canada and join the East, Middle and West Forks near the international boundary: Coal Creek, Cow Creek and the East Tributary. Other tributaries such as Butte Creek, Cottonwood Creek and Police Creek are located entirely in the U.S. part of the basin.

The Poplar River Power Plant is currently being completed at a site located approximately 4.3 miles north of the International Boundary (Figure 2.1-2). The site is located adjacent to a 1600-acre impoundment (Cookson Reservoir) which will be used as a water source for the plant's once-through cooling water system. The total storage volume of Cookson Reservoir is approximately 30,000 acre-feet. One 300 MW coal-fired plant is completed and a second 300 MW unit is under construction. The addition of two other 300 MW units may be feasible in the future if the necessary increased cooling water is available at the site.

4.2 GEOLOGY AND SOILS

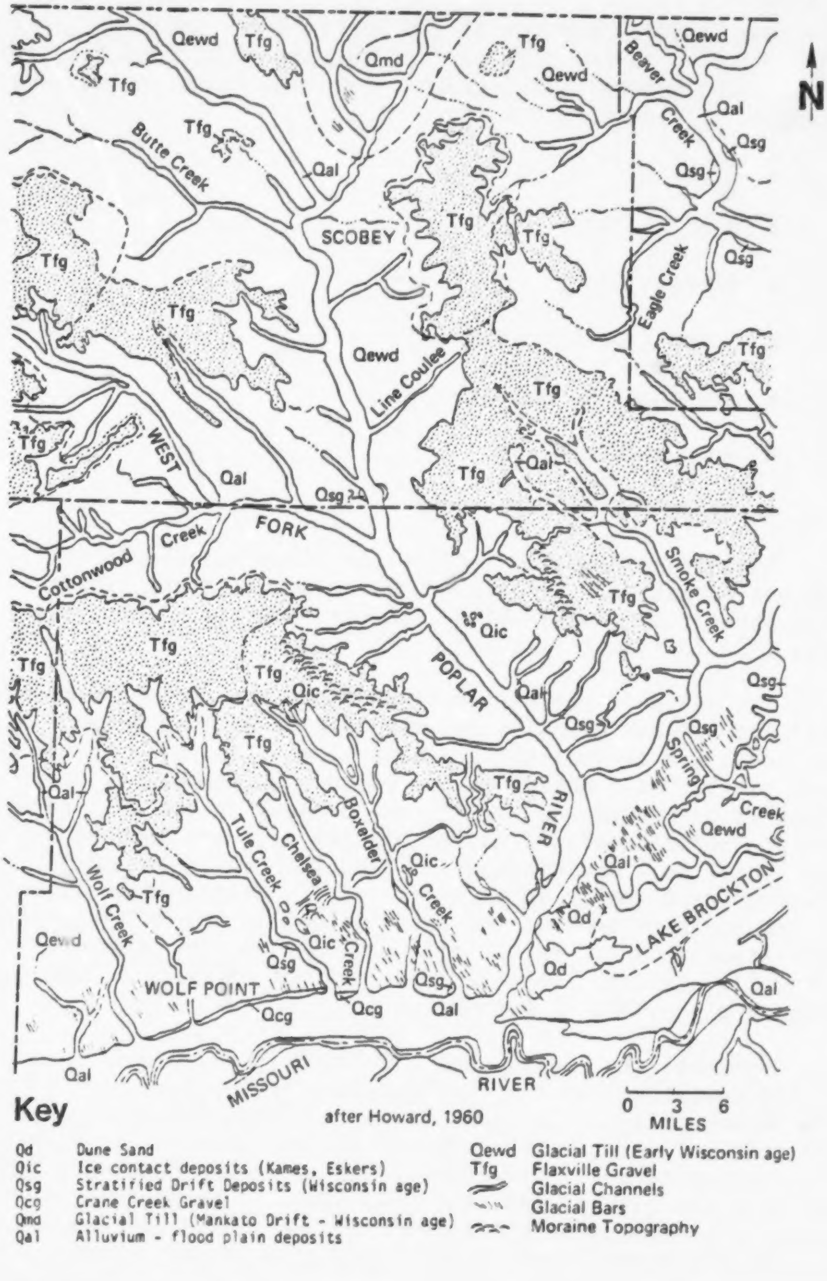
The Poplar River Basin is located in the Northern Great Plains. The area is characterized by flat to gently dipping sedimentary strata overlain by glacial deposits and alluvium in the river valleys. The study area is at the northern edge of the Williston Basin, a large syncline in Montana and North Dakota. The formations exposed in the area are the Bearpaw Shale, Fox Hills sandstone, and Hell Creek Formation of Cretaceous age; the Fort Union and Flaxville Formations of Tertiary Age, and Quaternary gravels, alluvium, and glacial deposits. The general stratigraphic section for the region and local variations within the Poplar Basin are discussed for the formations in Appendix A-1.

The Quaternary period can be divided into the Pleistocene series dominated by glacial activity and the Holocene series dominated by fluvial activity. The oldest formation which predates the glacial period is the Wiota Gravels. The location of glacial and recent deposits in the Poplar River Basin are shown in Figure 4.2-1. Generally, the till deposits consist of unstratified clay, silt, sand and gravel. The average thickness is 10 feet. Other types of glacial deposits include eskers, kames, glacial outwash sediments, and lake deposits.

Recent deposits include alluvium in the river valleys, colluvium in slope-wash and alluvial fans, landslide material, and sand dunes. The alluvium is composed of locally-derived sand, silt and gravel and may be up to 40 feet thick. Samples of the river banks analyzed by the Montana Department of Natural Resources and Conservation (1978) at nine locations along the entire Poplar River system were as follows:

Flood-plain	85-100%	Silty Loam
	5-15%	Gravel
Upper Bank	85-95%	Silty Loam
	0-5%	Sand
	2.5-15%	Gravel
Lower Bank	85-95%	Silt/Silty Loam
	5-15%	Sand and Gravel
Channel	40-85%	Silt
Channel	5-20%	Sand
	10-100%	Gravel

Along the Mainstem of the Poplar River below the confluence with the West Fork and the middle of the East Fork, the lower bank and channel are 100 percent gravel. Sand dunes occur southeast of Four Buttes and northeast of the town of Poplar. The dunes consist of gray sand with a relief of 10 feet. Vegetation stabilizes most of the dunes.



N
Qewd
Tfg
Qmd
Beaver Creek
Qal
Qsg
Butte Creek
SCOBEY
Eagle Creek
Line Coulee
WEST
FORK
Cottonwood Creek
POPLAR
RIVER
Smoke Creek
Qic
Spring Creek
Boxelder Creek
Chelsea Creek
Tule Creek
Wolf Creek
WOLF POINT
Qcg
Qd
LAKE BROCKTON
MISSOURI RIVER
Key
after Howard, 1960
0 3 6
MILES
Qd Dune Sand
Qic Ice contact deposits (Kames, Eskers)
Qsg Stratified Drift Deposits (Wisconsin age)
Qcg Crane Creek Gravel
Qmd Glacial Till (Mankato Drift - Wisconsin age)
Qal Alluvium - flood plain deposits
Qewd Glacial Till (Early Wisconsin age)
Tfg Flaxville Gravel
Glacial Channels
Glacial Bars
Moraine Topography

Figure 4.2-1 QUATERNARY GEOLOGY OF THE U.S. PART OF THE POPLAR RIVER BASIN

The Canadian portion of the Poplar River Basin has a similar geologic history to the U.S. part of the basin and thus has similar rock types. The general stratigraphic sequence found in the area from youngest to oldest strata is:

- Alluvium
- Glacial Till
- Empress Group
- Ravenscrag Formation
- Frenchman Formation
- Bearpaw Shale
- Older sedimentary rocks

Quaternary deposits include the alluvium, glacial till, and the Empress Formation. Alluvial deposits occur in the floodplain of the East Fork of the Poplar River and Girard Creek. The glacial till is less than 70 feet thick.

The soils in the Poplar River Basin are derived from the glacial till and outwash deposits and the locally exposed bedrock formations. The soils are predominantly a loam type. The soils in the Canadian part of the basin belong to the Brown and Chernozemic Brown groups. At least 12 different soil series are present in the U.S. part of the basin. Soils developed on the glacial till are predominantly Williams and Zahill Soil Associations. Floodplain soils are mostly Haverlon, Trembles, and Lohler soil series. Soils developed on till over bedrock in the southern part of the basin belong to the Phillips-Scobey-Thoeny Soil Associations. These soils are loam to clay loam with a lime zone at shallow depths. Detailed descriptions of the U.S. and Canadian soil types are provided in Appendix A-1.

Permeability ranged from low (0.06 inches/hour) to moderate (0.6 to 2 inches/hour) at the sampled sites in the U.S. part of the basin. Low permeability soils occur in parts of the floodplain and can restrict agricultural use of these areas. In the lower Poplar River Basin excessively high permeability soils (2 to 20 inches/hour) are found on hilly parts of the glacial till and sand dunes. The Banks soil series is sandy with high permeability and low water holding capacity (approximately 3.8 inches in the first four feet) (Klages, 1976).

Most of the irrigated lands in the Poplar River Basin have soils belonging to three soil series (Haverlon, Trembles, and Lohler). Approximately 75 percent of the irrigated soils in the area belong to the Haverlon and Trembles series (Smetana, 1979). Both of these soils are loam types. The Lohler soil is a fine loam with some montmorillonite. The average water holding capacity in the deep loam soils was estimated at 10 inches (USDA, 1964). Thus, the water requirement for spreader irrigation systems was estimated as 10 inches by the Poplar River Task Force. The crop requirement for gravity or pumping irrigation was estimated by the Task Force as five inches since the applications should take place when the soil moisture is 50 percent depleted. The total water requirement due to losses by seepage and evaporation was therefore estimated as 7.7 inches per irrigation application (Montana DNRC, 1978).

The chemical properties of the soils are an important factor in determining the suitability of the soils for agriculture. The CEC (cation exchange capacity) of soils on the Fort Peck Indian Reservation ranged between 15 and 44 meq/100 g. The pH of soils through the U.S. part of the Poplar Basin ranged between 7.5 and 9.5 (see Table A.1-2). Analyses of major cations including boron are included in Appendix A-1.

Mineral resources of the Poplar River Basin are associated with the flat-lying sedimentary strata of Cretaceous and Tertiary Age and the glacial deposits of Quaternary Age. Detailed descriptions of the fuel and non-fuel resources are included in Appendix A-1. Fuel resources include oil and coal. Oil has been produced from five fields in the Poplar River Basin. Several lignite coal fields exist in the U.S. part of the Poplar River Basin, although no coal is presently being mined. The fields have a low probability for development due to overburden and low Btu value (Montana Energy Advisory Council, 1976). There are 12 coal fields in the Canadian part of the basin. The Hart coal seam will be mined for the SPC power plant at a rate of 50 million tons per 300 MWe unit over the life of the plant.

Non-fuel resources include potash, quartzite, bentonite, sand, gravel, clay and marl. Potash is mined in Saskatchewan by the Pittsburgh Plate Glass Industries. The Farmer's Potash Company has plans for a mine and processing plant near Scobey, Montana.

4.3 LAND USE

4.3.1 General

The Poplar River Basin (Daniels and Roosevelt Counties) and adjacent Sheridan County are rural, sparsely-populated areas in which the majority of land is devoted to agricultural use (Table 4.3-1). In Daniels and Roosevelt counties over 98 percent of the total acreage is classified as cropland, pasture or rangeland.

On the Fort Peck Indian Reservation the majority (68%) of the reservation lands was used for open grazing in 1972. Only 30 percent of this land belongs to the Indians. The other major land use is farming. Sixty percent of the dry land farming is on land used by the Indians.

Table 4.3-1

LAND USE CHARACTERISTICS OF 1974 DANIELS AND ROOSEVELT COUNTIES EXPRESSED IN ACRES AND AS THE PERCENT OF THE TOTAL AREA

County	Total Area	Cropland	Harvested Cropland	Woodland	Other Agricultural Land	Miscellaneous
Daniels	923,456	556,182 60.2%	289,646 31.4%[a]	511 0.1%	324,508 35.1%	42,255 4.6%
Roosevelt	1,526,464	776,732 50.9%	381,570 25.0%	3,241 0.2%	728,466 47.7%	18,025 1.2%
Total	2,449,920	1,332,914 54.4%	671,216 27.4%	3,752 0.2%	1,052,974 42.9%	60,280 2.5%

[a] Percentage of total area in county

Data are from 1974 Census of Agriculture. U.S. Department of Commerce Bureau of the Census.

The majority of the land is privately owned in Daniels, Roosevelt, and Sheridan counties. Detailed tables for land ownership are given in Appendix A-2. In Daniels County the amount of federally-owned lands is relatively small (0.09%) and is comprised of about 850 acres of National Resource Lands and U.S. Fish and Wildlife Service refuge. About 23.9 percent of the land in Daniels County is owned by the state. The relative amount of federally owned lands in Roosevelt and Sheridan counties is greater and comprises 3.6 and 2.5 percent of the total areas, respectively. In Roosevelt County most of the federal land is owned by the Bureau of Indian Affairs (non-trust lands), while in Sheridan County almost all of the federal land is associated with the Medicine Lake National Wildlife Refuge.

The total land area of Fort Peck Indian Reservation is 2,093,124 acres. However, over 50 percent of the reservation land is owned by non-Indians. All deeded land, state and county, within the reservation is included in this ownership category, as well as all federally-owned land not assigned specifically for use by Indians. The remaining land is divided into three ownership categories, Tribal Indian Trust land owned by the tribe (11.3%), and individual allotted (30.2%), and federal government land assigned for use by Indians (4.1%).

4.3.2 Land Use Surveys

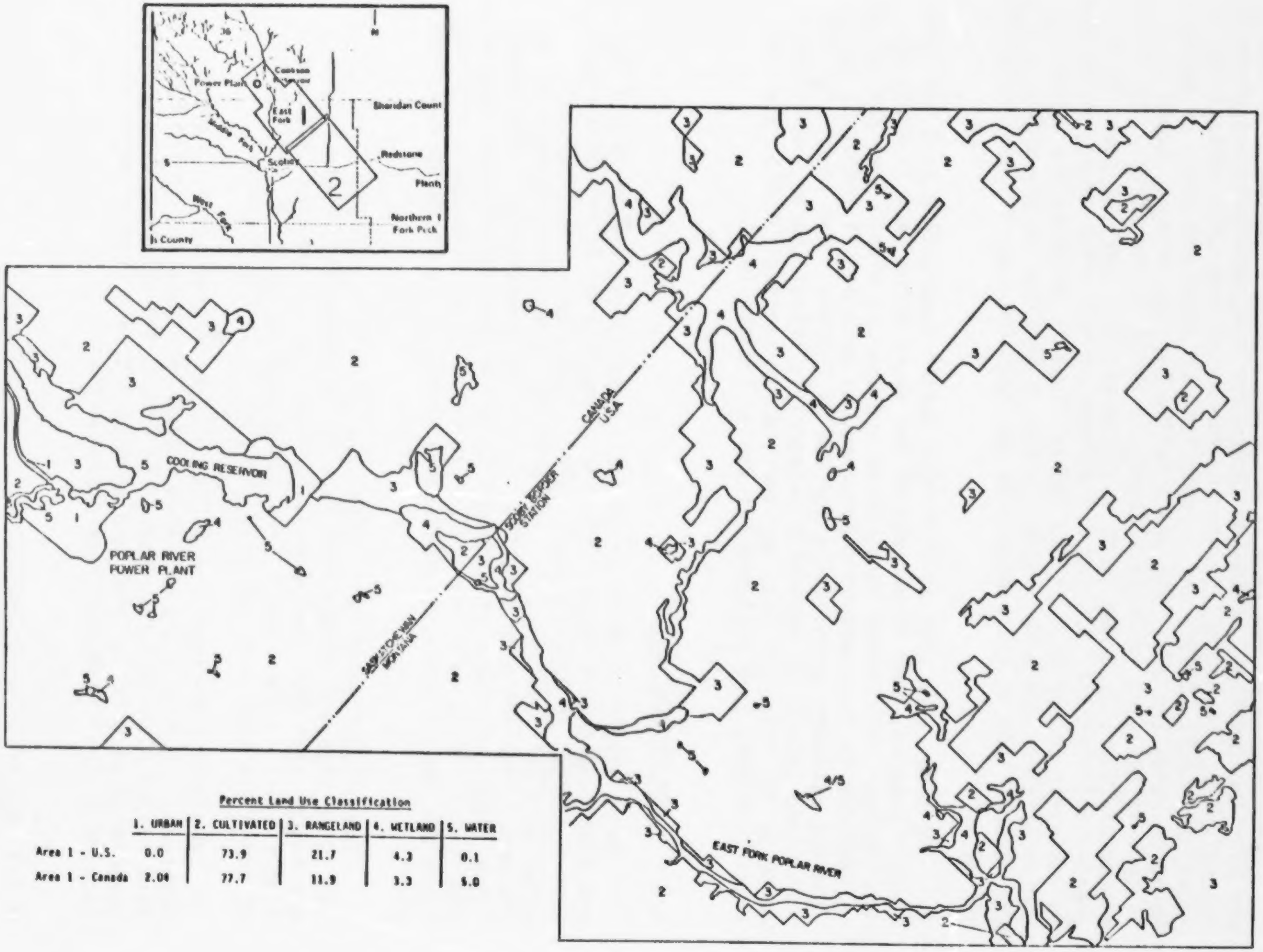
In an effort to describe land use classifications in detail in the direct down-wind region from the plant, aerial infra-red surveys were conducted in 1978 (Duggan, 1979). The area surveyed extends about 30 miles into the U.S. The area was selected to correspond to the most prevalent wind direction (i.e., north-westerly). Therefore, these areas would have the highest potential for impact resulting from atmospheric emissions from the Poplar Plant. The land use classifications for two of the surveyed areas are included as Figures 4.3-1 and 4.3-2.

The proportion of cultivated land in the U.S. (Areas 1 and 2) was quite high and ranged from 70.9 to 73.9 percent. These values are higher than the countywide values of about 60 percent cropland (Table 4.3-1). There was also a corresponding decrease in the amount of rangeland when compared with the overall county figures.

Wetlands comprised from 3.5 to 4.3 percent of the U.S. areas surveyed. In Area 1 the wetlands mapped were adjacent to the East Fork Poplar River and Cow Creek. In Area 2 the wetlands were directly associated with Eagle Creek and Whitetail Creek, both of which are located in the Big Muddy Creek drainage basin.

4.3.3 Agricultural Activities

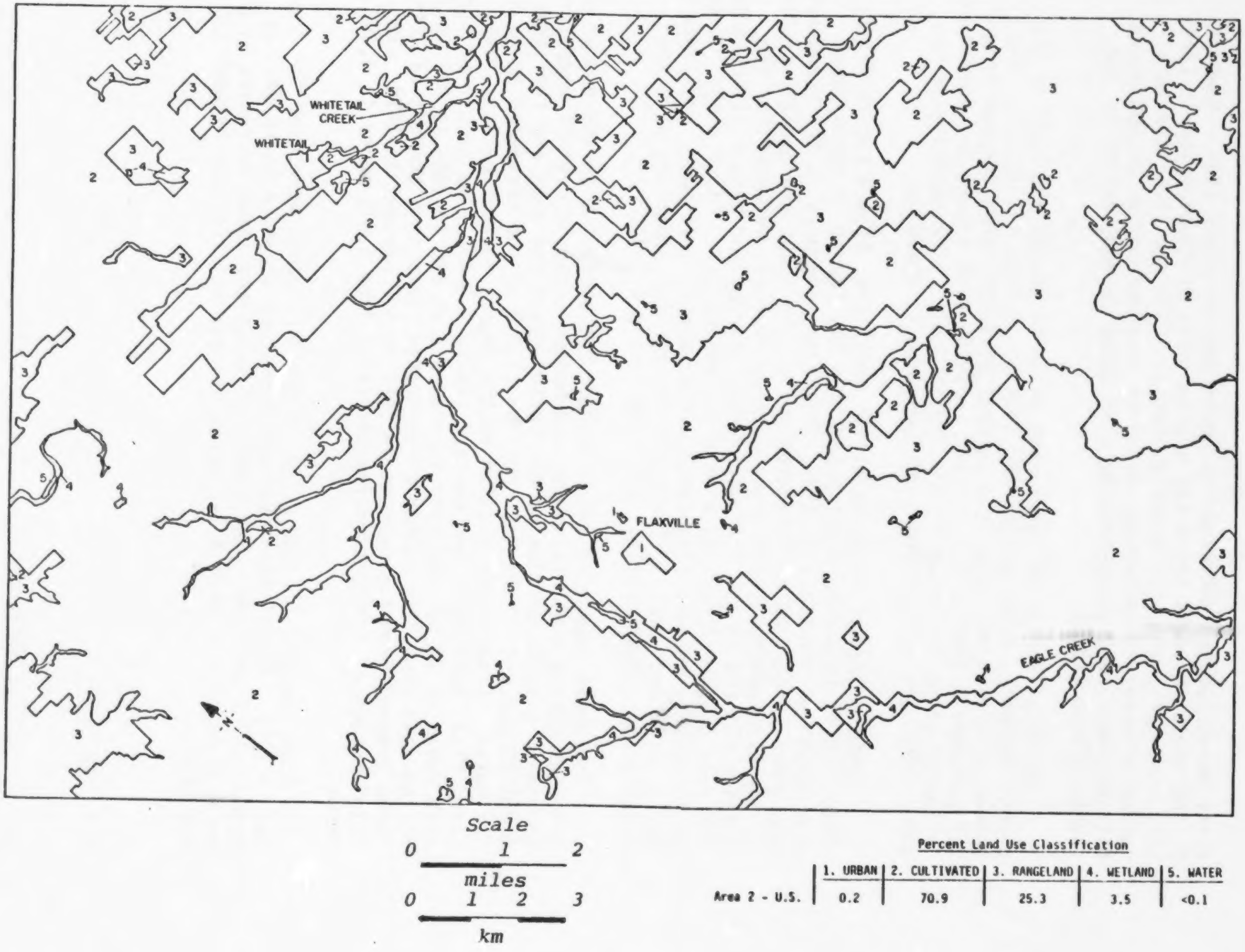
About 271,000 acres in Daniels County were harvested in 1975. Less than one percent of this acreage was irrigated. The number of


COOLING RESERVOIR
POPLAR RIVER POWER PLANT
CANADA
USA
SASKATCHEWAN
MONTANA
EAST FORK POPLAR RIVER
Power Plant
East Fork
Scobey
Sheridan Count
Redstone
Plenty
Northern
Fork Peck
West Fork
Middle Fork
County
1
2
3
4
5

Percent Land Use Classification

	1. URBAN	2. CULTIVATED	3. RANGELAND	4. WETLAND	5. WATER
Area 1 - U.S.	0.0	73.9	21.7	4.3	0.1
Area 1 - Canada	2.04	77.7	11.9	3.3	5.0

Figure 4.3-1. LAND USE IN AREA 1 SURVEYED BY DUGGAN (1978)


WHITETAIL CREEK
WHITETAIL
FLAXVILLE
EAGLE CREEK
Scale
0 1 2
miles
0 1 2 3
km

Percent Land Use Classification

	1. URBAN	2. CULTIVATED	3. RANGELAND	4. WETLAND	5. WATER
Area 2 - U.S.	0.2	70.9	25.3	3.5	<0.1

Figure 4.3-2. LAND USE IN AREA 2 SURVEYED BY DUGGAN (1978)

acres harvested has increased by seven percent since 1960. However, during those 15 years there was a great deal of fluctuation in acres harvested per year. For example, between 1974 and 1975, the total number of acres harvested decreased by nine percent or 26,800 acres. Cattle-, hog-, and sheep-raising also occur to some extent in the county (Table 4.3-2).

The total number of farms with sales of $2,500 and over in the county increased between 1969 and 1974 by 19 from 435 to 454. The number of irrigated farms as a percent of total farms dropped from 3.9 percent in 1969 to 3.1 percent in 1974, even though the number of irrigated acres increased from 1,269 to 2,016. The majority of the farms (88%) are either family or individually operated.

Daniels County, in spite of its small area (1,443 square miles), ranked third in spring wheat production and fourth in durum wheat production in the state in 1975. The crops produced in the study area are grown largely on nonirrigated soil. The crops are usually planted in strips, leaving unused areas between to conserve water for the acreage planted in the following year. Barley and oats contribute to the feed grains production within Daniels County. Other crops raised in the county include flax seed, winter wheat, safflower, sunflower and hay. Irrigated land in the county is used for producing wild and alfalfa hay, wheat, barley, and oats (Table 4.3-3).

Roosevelt County is ranked number one statewide in the number of acres of spring wheat harvested and number three in overall wheat production. A small portion of the spring wheat and oats are irrigated. About 30 percent of the hay crop, or 12,700 of the harvested acres is irrigated. Other crops planted in the county include barley, oats, rye, corn, flax, safflower, and mustard (Table 4.3-4). The number of farms with sales of $2,500 and over increased from 636 in 1969 to 659 in 1974. At the same time, the number of irrigated farms as a percent of total farms dropped from 6.1 percent in 1969 to 4.7 percent in 1974, with the total number of irrigated acres declining from 6,815 acres to 4,402 acres.

Approximately 675,000 acres within the county were used for grazing in 1977. All of the livestock inventory showed a sharp decline between 1973 and 1976. The number of sheep and lambs decreased by almost 50 percent. Table 4.3-5 shows changes in livestock between 1974 and 1976.

4.4 HYDROLOGY

4.4.1 Surface Water

The Poplar River Basin consists of four sub-basins draining a total of 3,002 square miles (Figure 4.4-1). The West, Middle, and

Table 4.3-2

LIVESTOCK INVENTORY FOR DANIELS COUNTY

Livestock	YEARS 1974	1975	1976
All cattle and calves	24,600	24,800	24,600
Milk cows and heifers that have calved	750	100	100
Beef cows and heifers that have calved	14,700	15,400	14,000
Stock sheep and lambs	5,000	4,500	5,000
Hogs and pigs*	5,400	5,900	4,800
Chickens*	2,700	2,000	1,300

*Inventory for the years 1973-1975.

Source: Montana Department of Agriculture, Montana Agricultural Statistics, December, 1976.

Table 4.3-3

ACRES IN IRRIGATED AND NON-IRRIGATED CROPS
DANIELS COUNTY, 1975

Crop	Irrigated Acreage	Non-Irrigated Acreage	Total Acreage	Percent of Total
Spring wheat	*	170,000	170,000	63
Barley	*	51,400	51,400	19
Durum wheat	0	16,600	16,600	6
Flaxseed	0	5,900	5,900	2
Oats	*	2,900	2,900	1
Winter wheat	0	1,500	1,500	1
All hay	2,500	20,200	22,700	8
Totals	2,500	268,500	271,000	100

*Spring wheat, barley, and oats are planted and irrigated as a cover crop in rotation with alfalfa, but total acreage of irrigated small grains is less than 1 percent of the total grain production (Montana Department of Agriculture, 1931-1977).

Table 4.3-4

CROP PRODUCTION, ROOSEVELT COUNTY, 1975

Crop	Bushels
All wheat	8,211,900
Winter wheat	1,158,700
Spring wheat, except durum	5,954,200
Barley	1,954,200
Oats	466,100
All hay	79,000*

*Tons

Source: USDA and Montana Department of Agriculture, Montana Agriculture, County Statistics, V. XVI, 1974 and 1975.

Table 4.3-5

LIVESTOCK INVENTORY, ROOSEVELT COUNTY

Livestock	Years			Percent Change
	1974	1975	1976	
All cattle and calves	50,400	44,000	35,000	-30
Milk cows and heifers that have calved	200	100	100	-50
Beef cows and heifers that have calved	27,900	26,200	21,700	-22
Stock sheep and lambs	4,500	2,600	1,900	-48
Hogs and pigs*	7,700	5,800	5,500	-29
Chickens*	10,600	9,200	5,800	-44

*Inventory is for the years 1973-1975.

Source: USDA and Montana Department of Agriculture, Montana Agricultural Statistics, V. XVI, County Statistics 1974 and 1975.

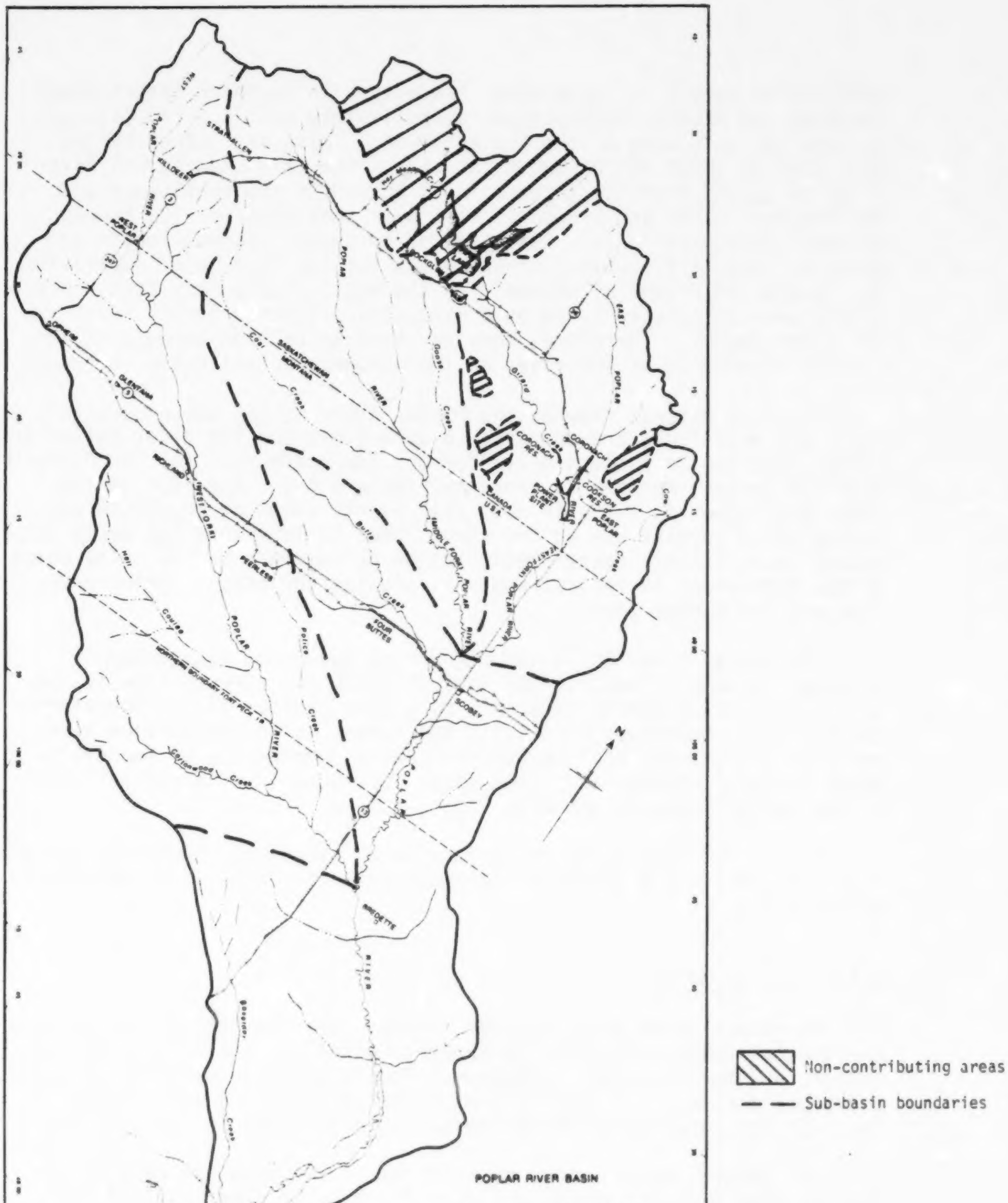

POPLAR RIVER BASIN
SASKATCHEWAN
MONTANA
CANADA
USA
CORONACH
SCOBEY
PEERLESS
FOUR BUTTES
RICHLAND
BREDETTE
EAST POPLAR
POPLAR RIVER
▨ Non-contributing areas
— — Sub-basin boundaries

Figure 4.4-1   MAJOR SUB-BASINS OF THE POPLAR RIVER SYSTEM

East Poplar rivers all have their headwaters in southern Saskatchewan. The East and Middle forks join at approximately 48°17' North latitude to fork the main stem of the Poplar River. These are joined by the West fork at about 48°50' North latitude. The main stem is 455 river miles in length from the International border to the confluence with the Missouri River and drops 450 feet over that distance (L. Brown, personal communications). Estimates of perennial channel length are shown in Table 4.4-1 with drainage areas for the four major sub-basins. The lengths of perennial channel for the West, Middle, and East Poplar rivers were calculated based on a sinuosity/projected length ratio for the lower Poplar. Therefore, they may tend to be high because of increased meandering of the river as the volume/gradient ratio increases.

The mean natural flow of the Poplar River at the basin outlet is 127.8 cfs. The mean flows are compared to 1975 flows for the river outlet and border stations in Table 4.4-2. The outflow hydrograph for the Poplar River at Poplar, Montana is shown in Figure 4.4-2. The flow in the water year shown is a one in 8.33 year event, somewhat above the expected value perhaps due to the strong peak in late June and early July caused by relatively heavy precipitation during that period. The shape of the hydrograph is typical however, showing the strong spring peak flow and low winter flow.

The Poplar River Basin has mostly low gradient, meandering alluvial streams. The alluvium through which the streams flow is two to six feet thick and is underlain by a deep glacial till. Therefore, the banks are constructed of silts and sands, while the streams have cut into the glacial till making the beds a combination of unconsolidated gravels, cobbles and loose sand. A schematic of a typical reach of the Poplar River is shown in Figure 4.4-3.

A detailed discussion of surface water hydrology, including annual flow frequencies and sediment transport characteristics, is included in Appendix A-3.

4.4.2 Ground Water

There are three major aquifers in the Canadian part of the basin - the glacial drift including the Empress Formation, the Ravenscrag Formation, and the Frenchman Formation. Ground water is used for domestic and stock purposes. A description of the aquifers and well yields in the U.S. and Canadian parts of the basin is included in Appendix A-4.

The general ground water flow regime in the Canadian part of the Poplar River Basin is shown in Figure 4.4-4. The upper part of the basin flows into Fife Lake. In dry or normal years there is no overflow from Fife Lake into Girard Creek. The only loss is from evaporation. In wet years there may be overflows as occurred in 1952-53 and 1975-76. The ground water in the lower Girard Creek sub-basin flows southeastward into the East Fork of the Poplar River. There is another loss to the basin in the East Fork sub-basin where the ground

Table 4.4-1

PERENNIAL STREAM LENGTH AND DRAINAGE BASIN AREAS FOR THE POPLAR RIVER BASIN

Basin Segment	Length of Perennial Stream (River-miles)	Order of Major Drainage	Area* Drained (mi^2)	Drainage Density $(mi)^{-1}$
West Poplar	390	2	1009	.39
Middle Poplar	244	2	(582)	.34
East Poplar	212	2	(485)	.32
Poplar	341	3	926	.37
TOTAL	1187	-	(3002)	.36

*Numbers in parenthesis indicate drainage areas without Fife Lake non-contributing area.

Table 4.4-2

COMPARISON OF EXPECTED ANNUAL FLOWS, MEAN FLOWS AND THE 1975 FLOWS IN THE POPLAR RIVER

River Segment	Expected Annual Flow (ac-ft)	Return Period (yrs)	Mean Annual Flow* (ac-ft)	1975 Flow (ac-ft)
West Fork @ I.B.	3,445	3.0	3,799	9,200
Middle Fork @ I.B.	11,790	2.7	12,961	34,040
East Fork @ I.B.	11,850	2.9	12,475	34,040
Poplar River @ Poplar, Montana	83,860	3.0	92,560	323,000

*Period of Record: 1931-1974.

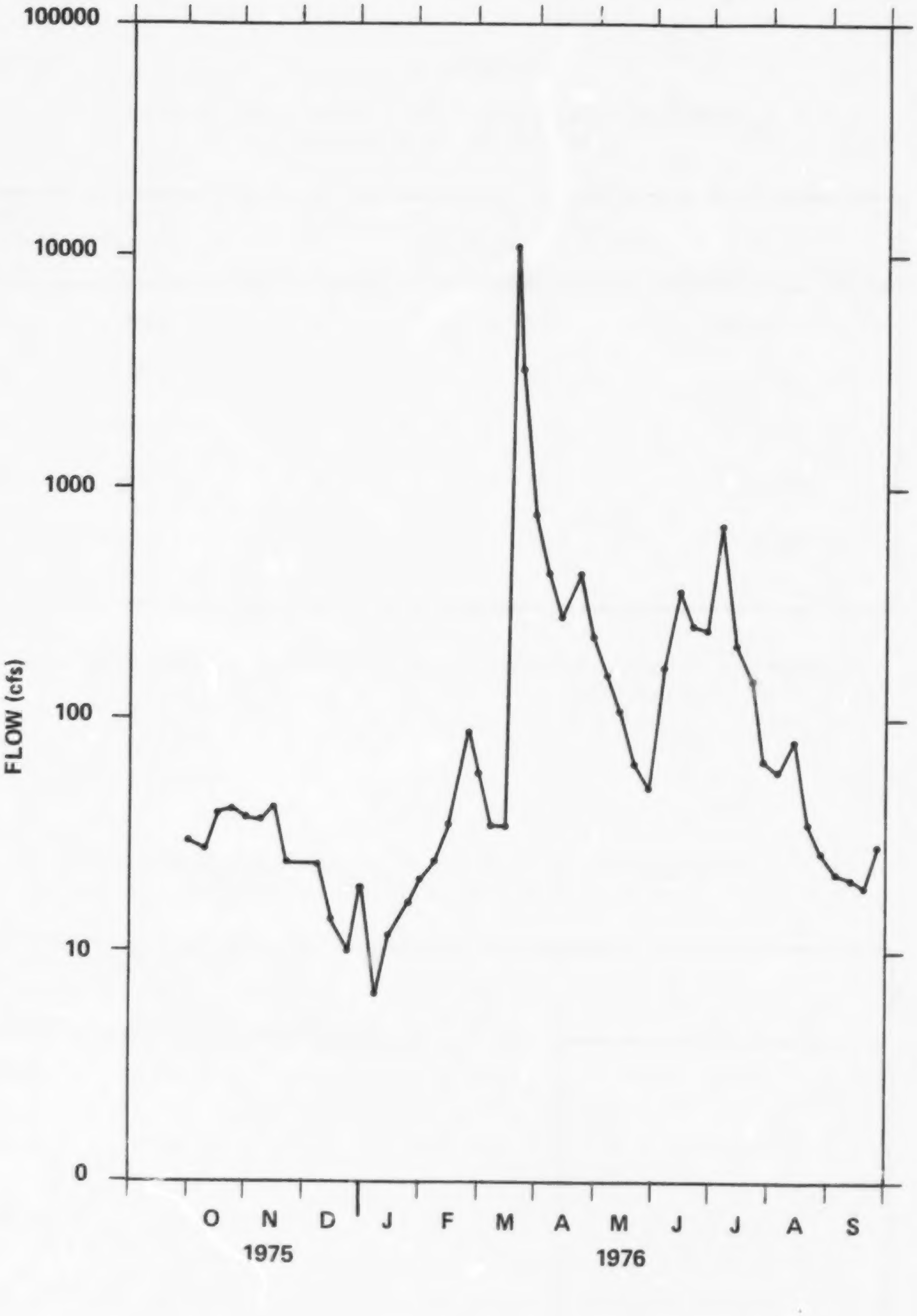


Figure 4.4-2 OUTFLOW HYDROGRAPH FOR THE POPLAR RIVER NEAR POPLAR, MONTANA, OCTOBER, 1975, TO SEPTEMBER, 1976

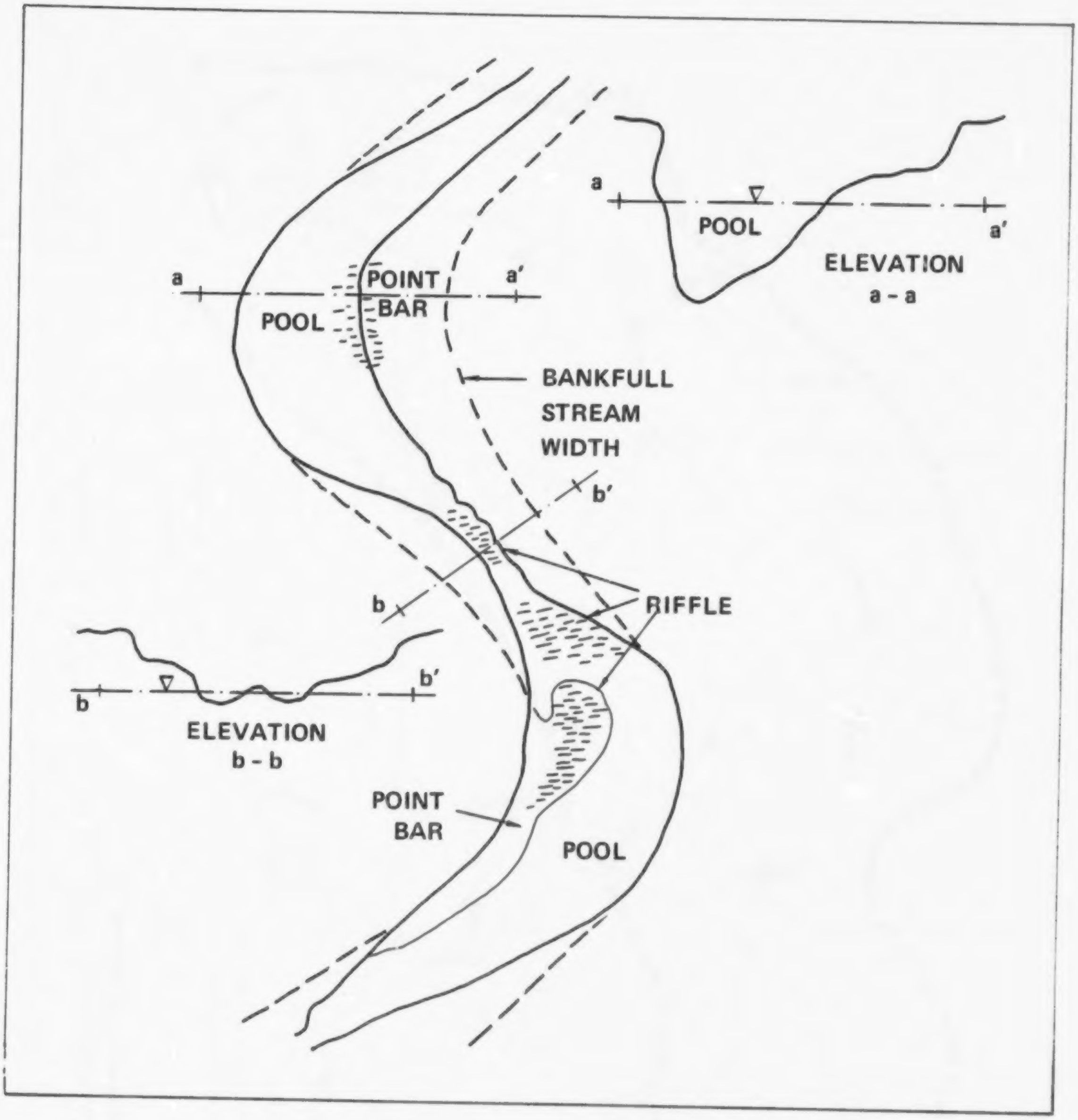

a
a'
POOL
ELEVATION
a - a
a
POINT
BAR
a'
POOL
BANKFULL
STREAM
WIDTH
b'
RIFFLE
b
b'
b
ELEVATION
b - b
POINT
BAR
POOL

Figure 4.4-3 SCHEMATIC OF TYPICAL REACH OF THE POPLAR RIVER

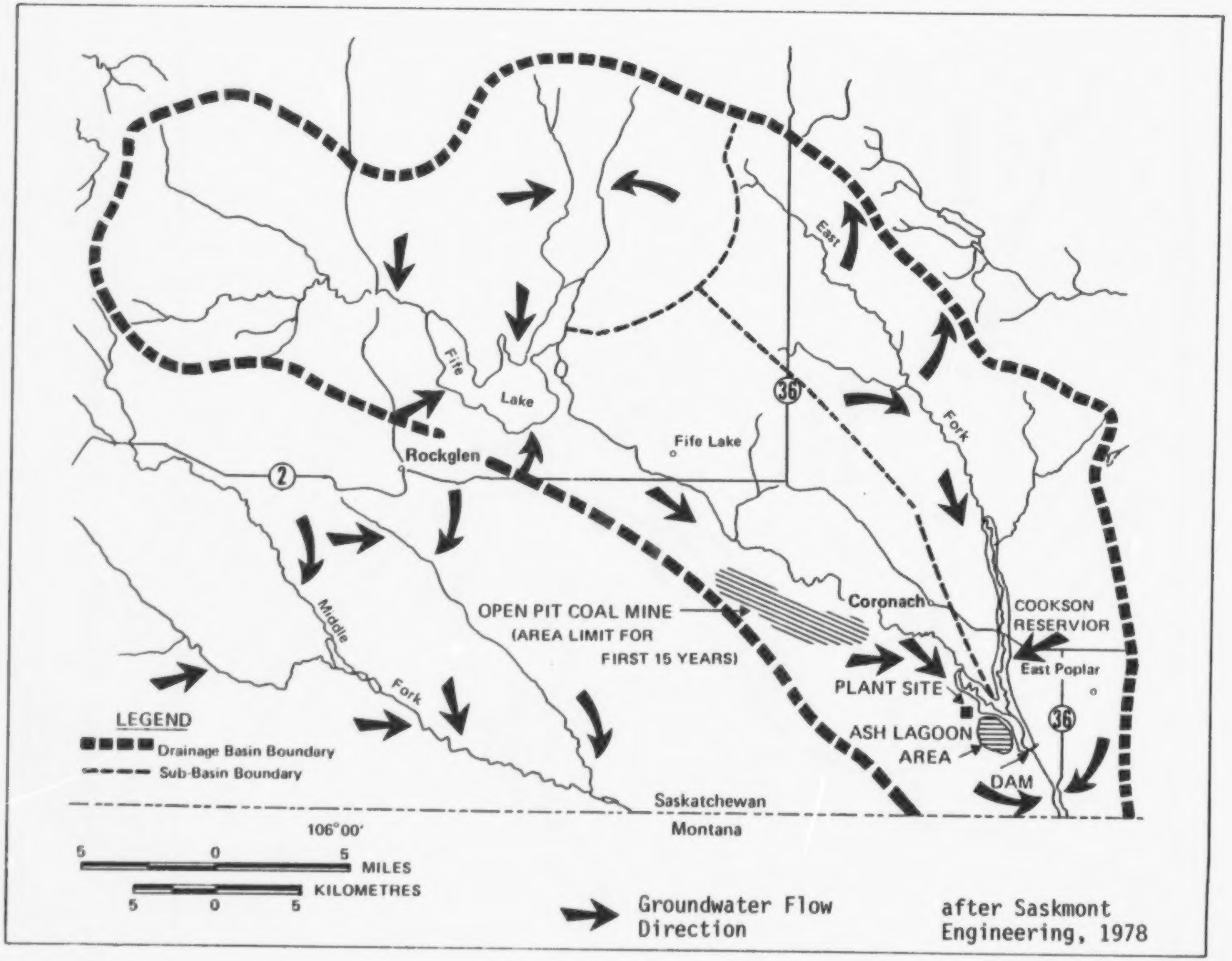

East
Fork
Fife
Lake
Fife Lake
36
Rockglen
2
Middle
Fork
OPEN PIT COAL MINE
(AREA LIMIT FOR
FIRST 15 YEARS)
Coronach
COOKSON
RESERVIOR
East Poplar
PLANT SITE
ASH LAGOON
AREA
DAM
Saskatchewan
Montana
LEGEND
Drainage Basin Boundary
Sub-Basin Boundary
106°00'
5 0 5 MILES
KILOMETRES 5 0 5
Groundwater Flow
Direction
after Saskmont
Engineering, 1978

Figure 4.4-4 GROUNDWATER FLOW REGIME IN CANADIAN PART OF POPLAR RIVER BASIN

water flows northward into a series of lakes including Bonneau, Rivard and Montague. The lower East Fork sub-basin flows south toward the border. The East Fork area just north of the International border is a ground water discharge area.

The major aquifers in the U.S. part of the basin are the Fox Hills-Hell Creek Formations, Fort Union Formation, Flaxville Formation, Wiota gravels, glacial deposits, and alluvium. The wells supply water for stock and domestic purposes but few wells have high enough yields for large-scale irrigation. The flow regime in the U.S. part of the basin is similar to the topography. Feltis (1978) conducted a detailed study in the East Fork sub-basin from the Canadian border south to the northern boundary of the Fort Peck Indian Reservation. A generalized ground water contour map for the shallow unconfined aquifers is shown in Figure 4.4-5. A detailed ground water level contour map also showing the chemical composition is included in Appendix A-4. The direction of flow in the recharge areas at higher elevations is into the upper aquifers--the glacial outwash and Flaxville Formation. The ground water then flows into the Fort Union Formation and partly into the streams and deeper formations. Ground water may flow down the river valley for several miles before discharging into a section of the Poplar River (Feltus, 1978). The detailed flow regime in the southern part of the Poplar River was not available. The expected flow directions are from the basin divides toward the river and then down to the Missouri River.

Primary recharge areas in the U.S. part of the basin are the plateaus and terraces along the sub-basin divides. Most of the recharge is from precipitation within the basin with additional inflow across the International border. Irrigation along tributaries and in the floodplain provides some recharge to the shallow ground water aquifers. At the time of spring runoff (usually March or April) the Poplar River may recharge the Quaternary alluvium. During other periods the stored water would return to the river.

4.5 WATER QUALITY

4.5.1 Surface Water

Surface water quality data for the baseline year 1975 as requested by the EPA and data after completion of the reservoir (1976-1979) are compared to the appropirate water quality standards and criteria. The sampling stations are located in Figure 4.5-1. A statistical summary of the data is included in Appendix A-5.

Comparing sites on the Canadian East Poplar River (C1 and C6), water quality appears to deteriorate substantially moving downstream. In general, concentrations of the following water quality constituents increase:

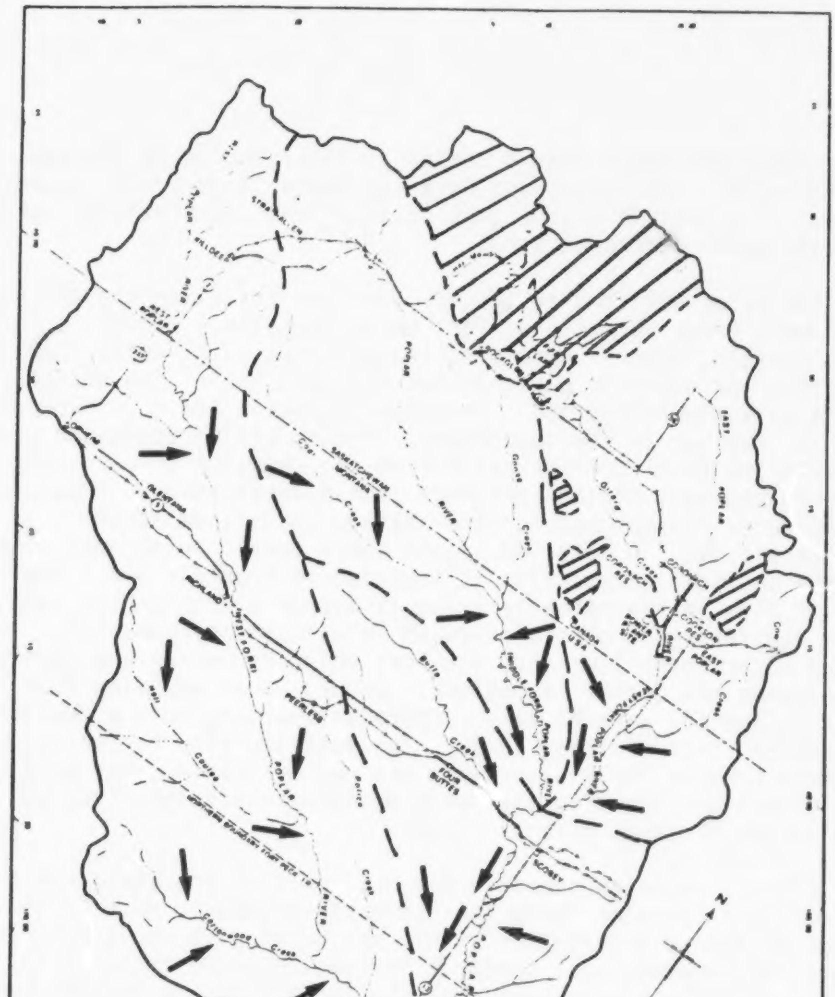

Key
Ground water flow direction
▨ Non-contributing areas for surface water
Sub-basin boundaries
SASKATCHEWAN
MONTANA
CANADA
U.S.A.
RICHLAND
PEERLESS
FOUR BUTTES
SCOBEY
Cottonwood Creek
POPLAR RIVER
N

Figure 4.4-5 General Ground Water Flow Regime in U.S. Part of Poplar River Basin

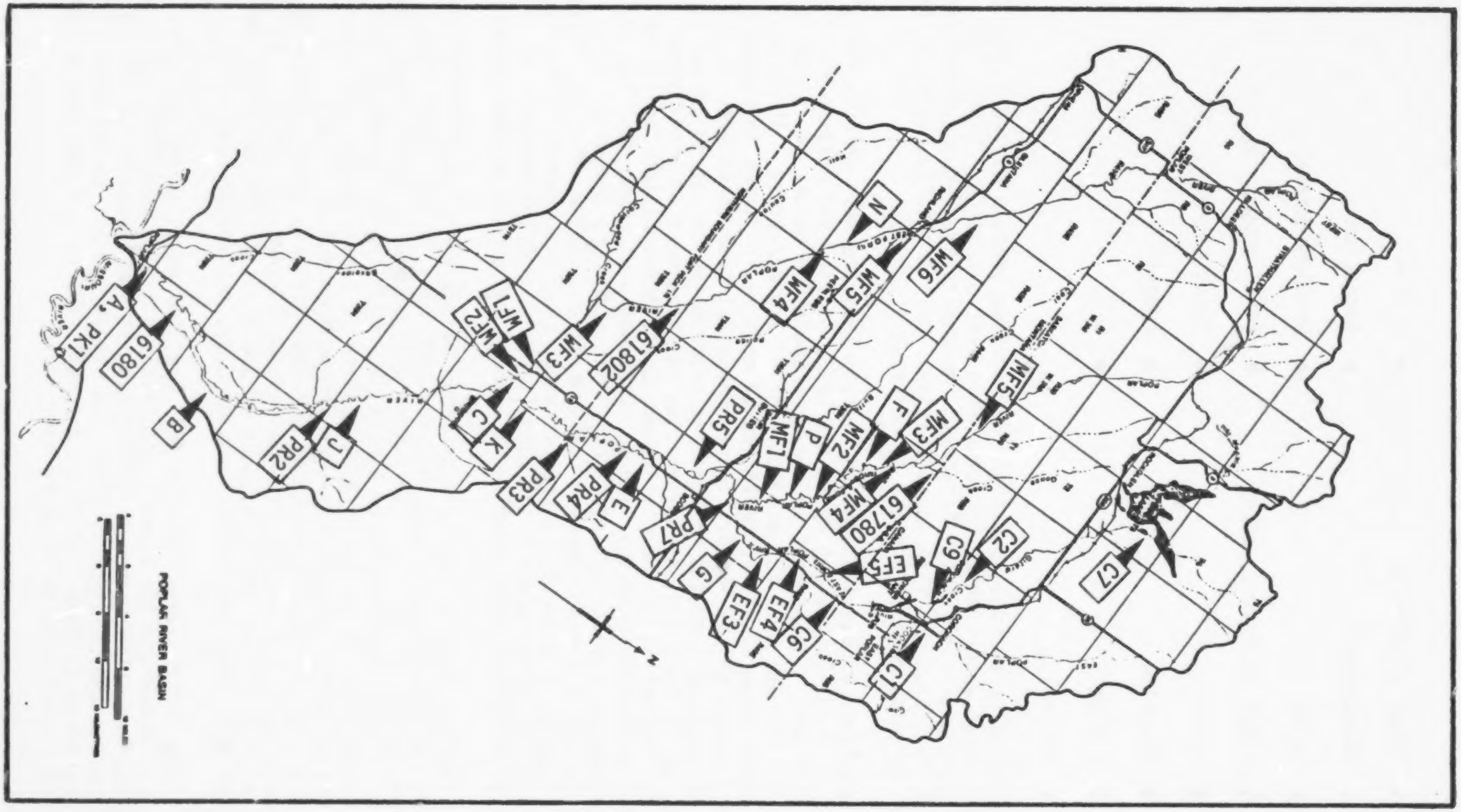

POPLAR RIVER BASIN
N
C7
MF5
C2
C9
WF6
MF3
F
61780
EF5
C1
N
WF5
MF2
MF4
P
C6
WF4
MF1
EF4
EF3
PR5
G
PR7
61802
E
PR4
WF3
PR3
WF1
WF2
K
C
J
PR2
B
6180
A, PK1

Figure 4.5-1 LOCATION OF WATER QUALITY SAMPLING STATIONS

- Total alkalinity
- Conductance
- Color
- Total dissolved solids
- Sulfate
- Chloride
- Silica
- Magnesium
- Sodium
- Potassium
- Orthophosphate
- Total phosphorus
- Total nitrate
- Ammonia
- COD

These parameters probably exhibit an increase because of the influx of Girard Creek water, which includes Fife Lake discharge. Since Fife Lake discharges only intermittently, the waters are high in dissolved solids due to evaporative concentration. Only turbidity, calcium, and total hardness do not increase or decrease slightly.

Analyses of gamefish muscle tissues indicate mean mercury concentrations of about 0.5 mg/wet kg in the East, Middle, and West Forks of the Poplar River. The highest values were about 0.9 mg/wet kg, slightly less than the current U.S. FDA action level of 1.0 mg/wet kg. These data indicate a significant accumulation of mercury in fishes throughout the upper reaches of the Poplar River. Potential sources of mercury include use of existing supplies of mercuric acetone (which can no longer be manufactured in the U.S.), as a fungicide for treatment of wheat seeds, domestic sewage, dewatering of the coal seams, power transmission facilities submerged by Cookson Reservoir and an abandoned waste dump near the reservoir (testimony at Public Hearing, 1980). Since mercury and other metals may be released to the environment during coal combustion, the occurrence and distribution of heavy metal contamination should be carefully monitored prior to and after power plant operation. A detailed analysis of this problem including field sampling is needed and should be undertaken.

The East Fork at the International boundary had total dissolved solids concentrations between 618 and 1480 mg/l in 1975 (USGS data). Sodium concentrations are fairly high with a mean up to 486 mg/l. Boron concentrations ranged between 1.0 and 3.7 mg/l in the summer of 1975 at the border and 1.5 to 3.2 mg/l at station G, close to the confluence with the Middle Fork. Dissolved oxygen varied from 4.4 to 12 mg/l. As elsewhere in the Poplar River system, the water is very hard, calcium-magnesium hardness typically being in the 300-400 mg/l range (as $CaCO_3$). Sulfate levels in the water are high (mean of 306 mg/l) as are both nitrogen (mean of 1.46 mg/l) and phosphorus (mean of 0.09, maximum of 0.4 mg/l).

Data for the West Fork for 1975 are limited to three stations in the summer. Water quality appears relatively uniform, especially with respect to dissolved solids concentrations which is low (mean of 700-800 mg/l TDS) relative to the East Fork. Dissolved oxygen appears to decrease slightly from upstream to down, but is high in all samples. Boron levels range from about one-half to slightly over 1 ppm.

Data for the Middle Fork for 1975 are also limited. Dissolved solids in the Middle Fork range between 511 and 1050 mg/l TDS. Suspended solids, are similarly high (up to 76 mg/l SS) and may, at times, be stressful to aquatic biota. Boron levels are uniform between 0.36 to 2.0 mg/l in the Middle Fork. The water is also hard with a range of 200-300 ppm of calcium-magnesium hardness. Dissolved oxygen concentrations are quite variable with a range of 4.6 to 8.2 mg/l at the border station.

Water quality data in the mainstem of the Poplar River in 1975 show mean TDS concentrations above 1000 mg/l. Sodium concentrations are high with means of 300 mg/l. Calcium and magnesium levels are similar to those in the other forks, and the water is classified as very hard. Boron levels are high, observations as high as 3.4 ppm having been made at station PR-4. Apparently, however, boron levels decrease downstream as the water approaches the confluence with the Missouri River. Phosphorus and nitrogen levels (based upon only three observations at USGS station 06181000) appear significantly lower in this part of the system than elsewhere. The dissolved oxygen concentrations are about 5 mg/l.

Recent data at the International Boundary are shown in Table 4.5-1. The concentrations of TDS and boron in the East Fork at the International Boundary show a decrease after 1975. The East Fork data also show less variation by month than the other forks. The pre-reservoir pattern of improved water quality in the spring due to the high runoff from snow melt no longer appears to occur. This is important because the spring runoff is used to fill ponds to be used for stock watering and irrigation throughout the summer. On the other hand the concentrations in the winter are less.

Federal Drinking Water Quality Standards. Available data for 1975 show that the only Federal primary standard for drinking water quality contravened was lead on the main stem and the East Fork. However, since the concentration values were reported as being "less than 100 ug/l," there may, in fact, have been no contraventions at all. The secondary standards for iron, manganese, pH, and TDS were contravened in at least one observation on all four branches of the river. Sulfate concentrations exceeded the secondary drinking water standard on the Middle and East Forks and on the main stem. There were insufficient data to evaluate barium, silver, chlorinated hydrocarbons, turbidity (because of units) and coliforms (all primary contaminants) and methylene blue active substances, hydrogen sulfide, and odor (secondary contaminants).

Federal Water Quality Criteria. Table 4.5-2 shows criteria and the locations where one or more contraventions occurred in 1975. The criteria for boron and iron are contravened in all four branches of the river. In all but the main stem, mercury values have apparently exceeded 0.05 ug/l, and in the East Fork, manganese has exceeded 0.1 mg/l. With respect to barium, fecal coliforms, color, cyanide, and nickel, data were inadequate to evaluate for criteria contraventions. In all other cases, existing data for 1975 did not show levels to be in excess of criteria.

Table 4.5-1

RECENT WATER QUALITY DATA FOR EAST, MIDDLE, AND WEST FORKS OF THE POPLAR RIVER AT THE INTERNATIONAL BOUNDARY

Concentration, mg/l

Month	West Poplar River		Poplar River (Middle Fork)		East Poplar River	
	TDS	Boron	TDS	Boron	TDS	Boron
1974 Dec	-	-	-	-	909	1.6
1975 Mar	-	-	-	-	910	1.3
Apr	-	-	-	-	689	1.1
May	-	-	-	-	712	1.0
June	-	-	-	-	1170	2.3
July	-	-	-	-	1430	3.1
Aug	-	-	-	-	1280	2.5
Sep	-	-	-	-	1040	1.8
Oct	-	-	-	-	936	1.8
Nov	-	-	-	-	1180	2.3
Dec	-	-	-	-	1180	2.3
Mean	-	-	-	-	1010	1.95
1976 Jan	-	-	-	-	927	1.8
Feb	-	-	-	-	901	1.7
Mar	-	-	-	-	97	0.12
Apr	-	-	-	-	194	0.27
May	-	-	-	-	875	1.9
June	-	-	-	-	-	1.3
July	855	1.1	511	0.9	956	1.8
Aug	809	1.2	865	1.4	891	1.6
Sep	861	1.1	1070	1.7	997	1.9
Oct	870	0.99	942	1.5	936	1.8
Nov	1070	1.0	678	0.89	927	1.8
Dec	1330	1.2	898	1.2	919	1.7
Mean	-	-	-	-	784	1.43
1977 Jan	1230	0.88	-	-	959	1.9
Feb	1250	1.1	-	1.0	925	1.7
Mar	645	0.59	740	0.77	873	1.7
Apr	478	0.49	698	0.80	862	1.8
May	809	0.85	900	1.1	949	2.0
June	1100	1.4	948	1.4	1060	2.0
July	1020	1.3	1140	1.9	833	1.9
Aug	976	1.1	1110	1.7	888	2.0
Sep	1010	1.2	1110	1.9	898	2.0
Oct	886	1.1	734	1.0	883	1.9
Nov	-	-	751	1.0	986	2.0
Dec	1710	1.8	1030	1.3	949	1.8
Mean	-	-	-	-	915	1.93
1978 Jan	-	-	1060	1.4	963	1.9
Feb	-	-	-	-	910	1.8
Mar	91	0.10	164	0.19	624	1.1
Apr	454	0.41	515	0.46	926	1.8
May	957	0.96	848	1.1	954	2.0
June	1240	1.3	317	1.1	932	2.0
July	1340	1.7	757	1.3	940	1.9
Aug	-	-	1050	1.7	889	2.0
Sep	858	1.2	755	1.1	967	1.8
Mean	-	-	-	-	923	1.8

Data are from Water Resources Data for Montana, U.S. Geological Survey

Table 4.5-2

U.S. EPA WATER QUALITY CRITERIA CONTRAVENTIONS ON THE POPLAR RIVER, 1975

			Branch of River[3]			
Parameter	Standard[1]	I[2]	West Fork	Middle Fork	East Fork	Mainstem
Alkalinity as $CaCO_3$	20					
Ammonia	.02[4]					
Arsenic	.10					
Barium	1.0	X				
Beryllium	11[5] μg/ℓ					
Boron	.75		●	●	●	●
Chromium	.10					
Fecal coliforms[6]		X				
Color	75 Pt-Co units	X				
Cyanide	.005	X				
Iron	1.0		●	●	●	●
Manganese	.10				●	
Mercury	.05 μg/ℓ[7]				●	●
Nickel[8]		X				
Dissolved Oxygen	5			●	●	
pH	5-9 units		●	●	●	
Hydrogen Sulfide	.002					

Notes:
[1] In mg/ℓ except as noted.
[2] "X" in this column means inadequate data to evaluate.
[3] "●" in these columns means one or more known contraventions.
[4] Unionized ammonia, a function of pH and temperature.
[5] Most stringent, for protection of aquatic life in soft, freshwater.
[6] Depends upon method of assaying.
[7] For protection of freshwater aquatic life and wildlife.
[8] Defined in terms of the LC50 for aquatic life.

State Water Quality Standards. Montana State water quality standards for waters of B-D_2 classification (including the Poplar River Basin) are, with the exception of toxic substances and fecal coliforms, expressed in terms of anthropogenic increases above, or changes in, natural conditions. Standards cover pH, dissolved oxygen, sediment, turbidity, and color.

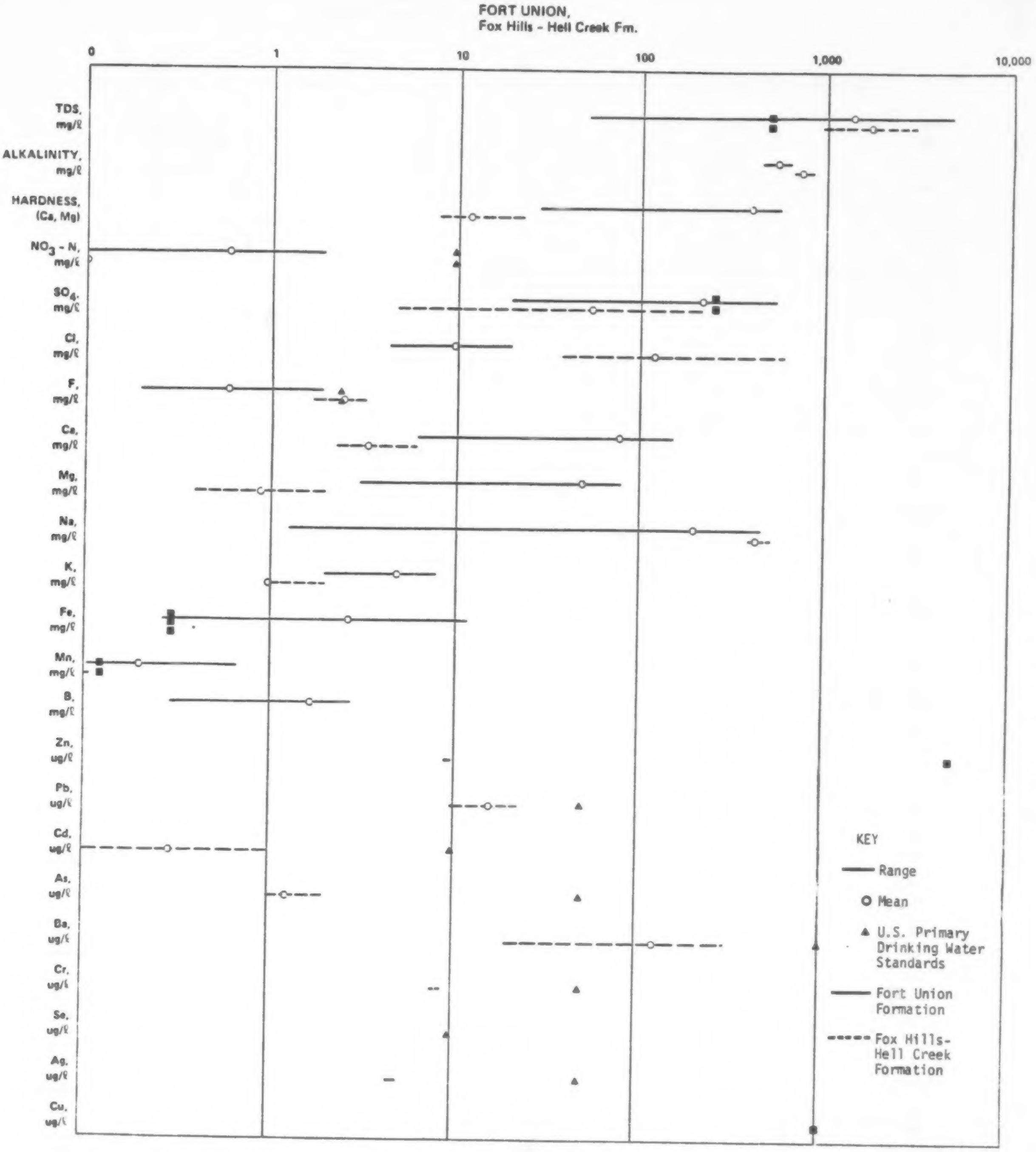
Toxic substances are considered in the same way, i.e., with respect to anthropogenic increases, but also with regard to Federal drinking water standards. These were discussed earlier. Fecal coliforms are considered in terms of proportions of samples having more than some number of organisms per unit volume during a set time period. The available data are inadequate to evaluate coliforms contraventions.

4.5.2 Ground Water Quality

Ground water quality data were available for 65 wells in Canada and 20 in the U.S. Detailed water quality data tables are included in Appendix A-5. The following section describes the general chemical water types found in the basin. The water in all formations except the Flaxville Formation is alkaline and high in total dissolved solids (TDS). The data show a sodium bicarbonate type water in the alluvium and Fox Hills-Hell Creek Formation although the latter may contain some carbonate. The Fort Union Formation may have a sodium or magnesium bicarbonate water. One sample from the Flaxville Formation was lower in dissolved solids with more calcium than magnesium or sodium. The available data for the Canadian wells show a similar pattern to the U.S. wells with the glacial drift water a calcium and magnesium bicarbonate type. The Ravenscrag Formation samples were a sodium bicarbonate-sulfate type water with very low calcium and magnesium.

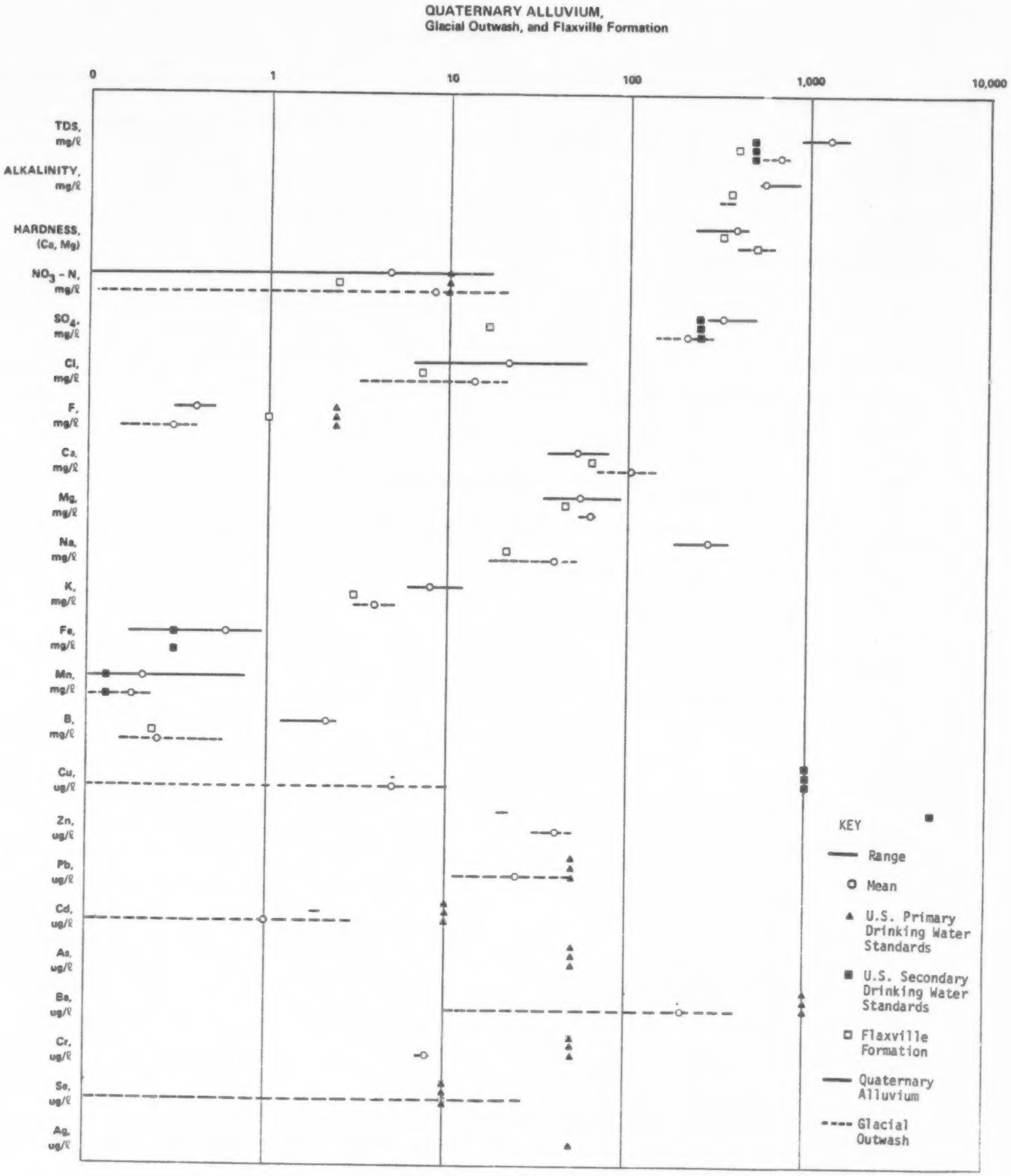
One of the major uses of ground water in the basin is for domestic water supplies. The available data were compared to the U.S. EPA primary and secondary drinking water standards. Figures 4.5-2 and 4.5-3 show the range of water quality data for selected parameters and the standards. A detailed description of the standards is included in Appendix A-5.

Ground water is used for stock watering in approximately 72 percent of the wells and springs in Daniels and Roosevelt counties (Klarich, 1978). Water quality guidelines for livestock from the EPA, Montana, and the California State Water Quality Control Board were compared with the available data. The Fox Hills-Hell Creek Formation samples exceeded the guidelines of 1 mg/ℓ Fluoride and 500 mg/ℓ HCO_3. Water samples from the Fort Union Formation and Quaternary alluvium also contained HCO_3 above 500 mg/ℓ. One sample from a well completed in the Fort Union Formation had sulfate levels above the threshold value of 500 mg/ℓ. One sample from a well completed in the Fort Union Formation had sulfate levels above the threshold value of 500 mg/ℓ but below the limiting value or 1000 mg/ℓ. Guidelines were met for the following selected cations and heavy metals:



Data from Feltis, 1987 and U.S. EPA, 1977

Figure 4.5-2. RANGES OF SELECTED CHEMICAL PARAMETERS IN WATER SAMPLES FROM THE FORT UNION FORMATION AND FOX HILLS-HELL CREEK FORMATION IN THE U.S. PART OF THE POPLAR RIVER BASIN



Data from Feltis, 1978 and U.S. EPA, 1977

Figure 4.5-3 RANGES OF SELECTED CHEMICAL PARAMETERS IN WATER SAMPLES FROM QUATERNARY ALLUVIUM, GLACIAL OUTWASH AND FLAXVILLE FORMATION IN THE U.S. PART OF THE POPLAR RIVER BASIN

- Calcium
- Magnesium
- Sodium
- Arsenic
- Aluminum
- Boron
- Cadmium
- Chromium
- Cobalt
- Copper
- Fluoride
- Lead
- Mercury
- Nitrate + Nitrite
- Nitrite
- Selenium
- Vanadium
- Chloride

The TDS concentrations in the ground water would classify the water as good (less than 2,500 mg/ℓ) by Montana's salinity classification. Water from some of the wells completed in the Quaternary and Fort Union Formations would be classified as excellent (less than 1,000 mg/ℓ) under the EPA's system (EPA, 1975).

Small numbers of wells are used for irrigation. The ground water in the basin would be assigned to Class II of McKee and Wolf (1963) on the basis of the high conductance, TDS, sulfate, and sodium concentrations. Class II ground water has a medium to very high salinity hazard and is suitable for irrigating tolerant to semi-tolerant crops including barley, hay, alfalfa, and wheat. A recent study by Klages (1976) investigated the irrigation potential and hazards of irrigation in the Poplar River Basin. This study recommended a limit of 1,500 µmhos/cm for conductance (at 25°C) and SAR values (sodium adsorption ratio) less than 7.5 to 8. Water from the glacial outwash deposits, the Flaxville Formation and a few wells in the Quaternary alluvium and Fort Union Formations could be used for irrigation based on these criteria. Boron levels in the glacial outwash and Flaxville Formation are less than 0.67 mg/ℓ so the water could be used for sensitive crops. Boron concentrations in the Quaternary alluvium and Fort Union Formation are mostly between 1.4 and 2.4 mg/ℓ which would be suitable for semi-tolerant or tolerant crops. Other elements which exceeded guidelines in at least one well were manganese, fluoride, molybdenum, iron, and selenium.

In the Canadian part of the basin most wells are used for domestic water supplies and stock-watering. The range of chemical parameters and the Canadian and Saskatchewan standards for drinking water, stock use and irrigation are discussed in detail in Appendix A-5.

4.6 WATER USE

4.6.1 Municipal Use

In the U.S. part of the basin the only municipal water use is by the City of Scobey, Montana. The water is pumped from shallow wells adjacent to the Poplar River at a current capacity of about 750 gpm (3.31 acre-feet/day). The wells are recharged primarily from the Poplar River. During 1975, municipal water use by Scobey was 210 gal/person/day, or a total of 0.95 acre-feet-day (Montana DNRC, 1978). This represents an annual use of about 347 acre-feet.

In Canada the only municipal water use is a shallow well located adjacent to Coronach Reservoir serving the Village of Coronach, Saskatchewan. In recent years the annual water use has ranged from 20 to 40 (average 36) acre-feet. It is assumed that almost all of the use represents a surface water depletion (Poplar River Task Force, 1976).

4.6.2 Industrial Use

There is currently no industrial use of water in the U.S. or Canadian parts of the Poplar River Basin. The Farmer's Potash Company has applied for a permit in Montana but this has been delayed pending outcome of the apportionment.

4.6.3 Agricultural Use

Consumptive water use for agricultural purposes is associated with stock watering and irrigation. Water consumption for stock watering activities results from two separate actions: evaporation from stock water holding reservoirs and actual consumption by livestock.

In the U.S. part of the basin, information on water use projects for agricultural purposes has been estimated based on water resource surveys, field inspections and aerial photographs. In the Canadian basin data were also available from project owner's records of pumping rates. This information was then used in conjunction with assumptions on crop requirements, soil characteristics and water availability to estimate total water use. The assumptions used for both U.S. and Canadian parts of the basin are listed in the Poplar River Task Force Report (1976).

4.6.3.1 Montana Water Use

For the U.S. part of the basin outside of the Fort Peck Indian Reservation, the 1975 water use for livestock was 432 acre-feet for stock watering and 452 acre-feet due to reservoir evaporation (Montana DNRC, 1978).

The historical use of water for irrigation by gravity/pump diversion is variable depending upon river flow (Figure 4.6-1). Since 1960 there has been a large increase in irrigation usage which has generally fluctuated between 2,500 and 5,000 acre-feet per year in the U.S. part of the basin.

In 1975, a total of 5,900 acre-feet was used for irrigation by gravity and pumping and 3,076 acre-feet by spreader irrigation in the U.S. basin exclusive of the Indian Reservation. This relatively high water usage reflects the correspondingly high availability of water during 1975, which allowed for a total of four applications. During the last 45 years there have been only three years, however, in which water availability in the basin allowed for four applications. During the period of record, the average number of applications was 2.4 (Dooley, 1975). A breakdown by sub-basin of irrigation water usage in the non-Indian Reservation U.S. part of the basin is shown in Appendix A-5.

4.6.3.2 Water Use on the Fort Peck Indian Reservation

On the Fort Peck Indian Reservation all existing (1975) water uses are associated with agricultural activities. A detailed breakdown by sub-basin is shown in Appendix A-5. In a survey conducted by the Fort Peck Sioux and Assiniboine Tribes and Morrison-Maierle, Inc. (1978), a total of 283 stock ponds were identified on the reservation. The total water uses for livestock consumption and evaporation were 287 acre-feet and 600 acre-feet, respectively.

A total of 12 existing irrigation projects were also identified. Of these, four projects used gravity or pump diversion systems to irrigate alfalfa, native hay, truck gardens or barley. The total acreage used for gravity/pump systems in 1975 was 306. Estimates were also available for the actual water use in irrigation projects during 1975. Since 1975 was a high runoff year, four irrigation applications were conducted. Based on a total application of about 31 inches, the estimated use was 785 acre-feet. All of the 1975 use associated with gravity/pump irrigations was from two sub-basins of the Mainstem of the Poplar River (boundary to West Fork and Hay Creek to Missouri River). An additional area of 299 acres on the Indian Reservation was irrigated by eight spreader dike systems during 1975. Based on a single 10-inch application, the total water use was estimated at 299 acre-feet. Crops irrigated by spreader dikes were alfalfa and native grasses.

During the period from 1955 to 1975, consumptive water uses on the Indian Reservation for stock watering and spreader irrigation have remained relatively constant (Figure 4.6-2). The annual water use for gravity/pump irrigation has fluctuated from about 300 to over 1,500 acre-feet. During this period the total area irrigated by gravity/pump

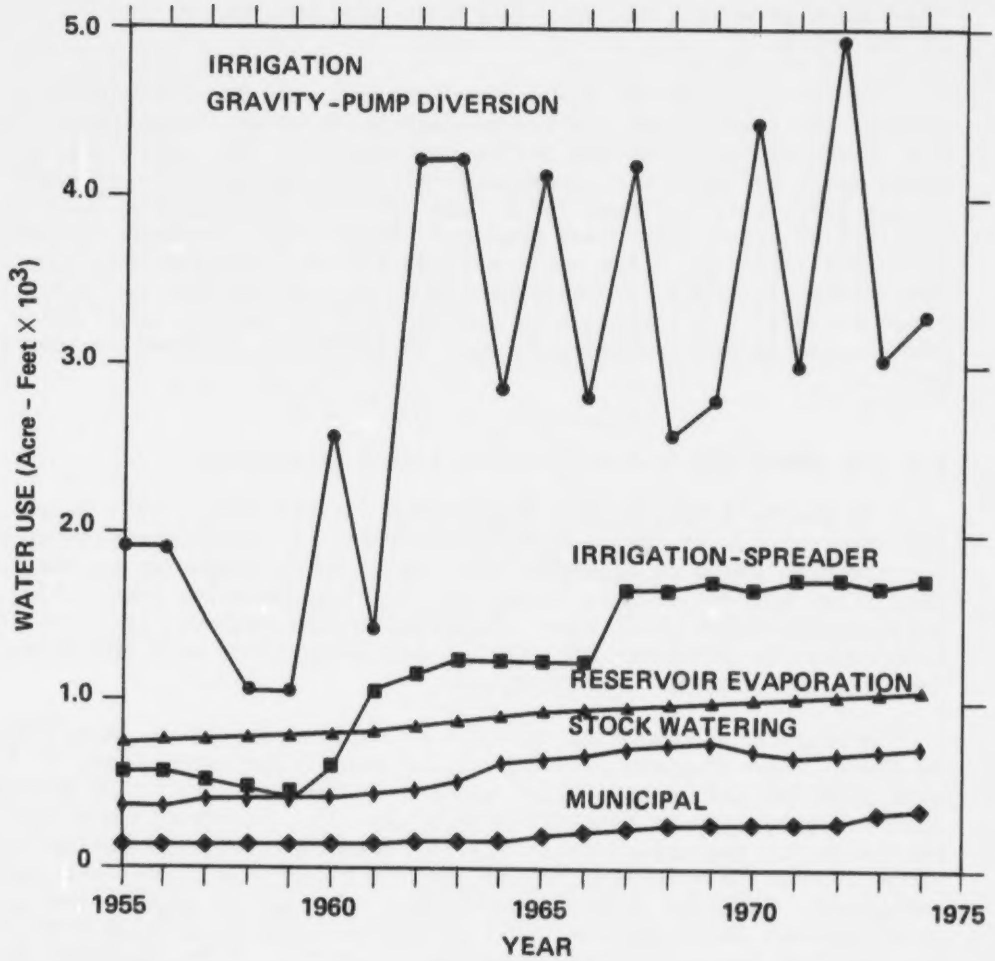


Figure 4.6-1 HISTORICAL WATER USE IN THE U.S. PART OF THE POPLAR RIVER BASIN 1955 THROUGH 1974. (Data from Poplar River Task Force, 1976)

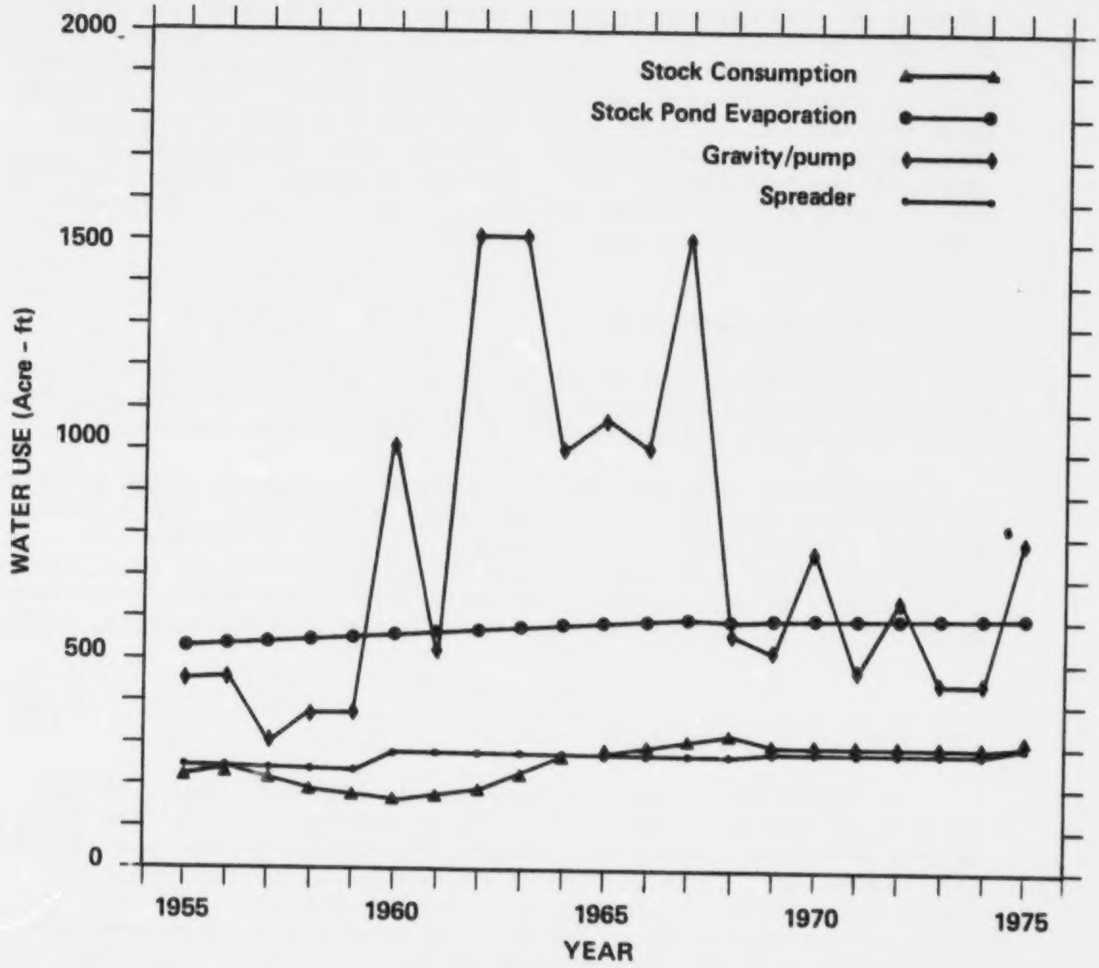


Figure 4.6-2 HISTORICAL WATER USES ON THE FORT PECK INDIAN RESERVATION 1955 THROUGH 1975. (Data from Morrison-Maierle, Inc. 1978)

systems varied from 236 to 786 acres. Much of the fluctuation in water use was due, however, to water availability and subsequent variations in the total number of irrigations per season.

Since 1975 was a high runoff year, the actual irrigation uses are probably not representative of the average existing water use at the 1975 level of development. Existing water use for gravity/pump irrigation is more appropriately defined by using 1975 levels of development (i.e., irrigated acreage) and average runoff values. Table 4.6-1 presents estimates of existing water use in the U.S. part of the basin assuming 2.4 irrigations per year and 0.641 feet per application (Poplar River Task Force, 1976). The use of these assumptions modifies only the gravity/pump irrigation uses, since stock uses and spreader dikes are less dependent upon the amount of runoff.

4.6.3.3 Canadian Water Use

In the Canadian part of the basin water use for agricultural purposes is associated with stock watering (consumption and pond evaporation), irrigation, and evaporation from several large reservoirs.

Agricultural uses for stock watering and irrigation under existing conditions are 182 and 319 acre-feet, respectively. The existing uses for each sub-basin in Saskatchewan are given in Section 5.2. With an additional 620 acre-feet use due to evaporation at three reservoirs (Clarke Bridge, Coronach and West Poplar), the total agricultural water use is 1,523 acre-feet (Saskatchewan Dept. of Environment, 1978).

4.7 VEGETATION AND WILDLIFE

The Poplar River Basin is dominated by cropland (wheat, barley and alfalfa) and grassland areas. The grasslands are comprised of a variety of grasses including: crested wheatgrass, yarrow, blue gramma and bluegrasses. Although coulees and breaks may contain areas of shrubs (e.g., rose, silver sage and chokecherry), there are very few stands of deciduous trees. The existing aspen poplars and green ash are confined primarily to the banks of the Lower Poplar River near its confluence with the Missouri River.

The Poplar River Basin provides important habitat for upland gamebirds, big game and waterfowl. Major upland gamebird species include the ring-necked pheasant, Hungarian partridge and sharp-tailed grouse. White-tailed deer is the main big game species; however, lower densities of mule deer and pronghorn antelope are also present. The occurrence of rare and endangered species is discussed in Appendix A-6.

Table 4.6-1

ESTIMATES OF EXISTING WATER USE FOR GRAVITY/PUMP IRRIGATION IN THE U.S. POPLAR RIVER BASIN

Sub-basin	Acres Irrigated	Estimated Water Use* (acre-feet)
International Boundary to Fort Peck I.R.		
East Fork†	65	100
Middle Fork	1,269	1,950
West Fork	389	598
Poplar River (main stem)	976	1,500
Maternach Coulee	137	211
Sub-Total	2,836	4,359
Fort Peck I.R. to Missouri River		
Poplar River to West Fork	250	384
Poplar River-West Fork to Missouri River	56	71
Sub-Total	306	470
TOTAL	3,142	4,829

*Based on 2.4 applications per year and 0.641 ft of water per application.

†Acreage is partly irrigated by small tributaries to the East Fork. The only diversions are near the confluence with Middle Fork.

Source: Poplar River Task Force (1976)

The aquatic habitat provided by the Poplar River is important for significant breeding populations of waterfowl such as mallards and American wigeons (an average of five breeding pairs/mile - DeSimone, 1979). The potential use of the river by waterfowl is an important consideration since flow modifications due to reapportionment could result in changes in available nesting and rearing habitat. Studies of waterfowl utilization of the Poplar River have been conducted by DeSimone (1979) and are discussed in Appendix A-6. Also included in the Appendix are detailed discussions of the vegetation types and terrestrial wildlife studies conducted in the basin.

4.8 AQUATIC BIOTA AND FISHERIES

The Poplar River supports relatively abundant game fish populations. In this regard it is distinct from most northern plains streams which are not generally considered as game fish habitat. The primary game species in the Poplar River Basin is walleye; however, northern pike are also common in most of the area. Smallmouth bass have been stocked and are apparently reproducing successfully in the main river near its confluence with the West Fork. Goldeye are also utilized by anglers; however, they are primarily restricted to the lower river.

Although the Poplar River supplies good fishing quality throughout much of the drainage basin, the actual angler utilization is low. Montana Department of Fish and Game has estimated that the entire Poplar River received a fishing pressure of only 2660 angler-days per year (State of Montana, DNRC, 1978). This represents an average usage of only 7.3 anglers per day of fishing throughout the year. The low fishing pressure is also reflected in the local Daniels County fishing license sales, which have averaged only 349 per year (1966-1976).

Due to the low population density, lack of projected population increases (see Section 4.10) and the proximity of popular fishing areas (e.g., Fort Peck Reservoir), it is anticipated that the Poplar River will continue to be utilized by anglers at a low level of fishing intensity. It is also expected that the usage will be primarily by local anglers.

Studies conducted by Montana Department of Fish and Game (1978) reveal that gamefish spawn throughout much of the U.S. Poplar River. Both walleye and northern pike require distinct spawning habitats in the Poplar River Basin. Walleye spawn over gravel bottoms in shallow water riffle areas while pike commonly use streamside vegetation as a spawning substrate. Both species spawn during high flow conditions following the spring ice breakup. Therefore, modifications of the natural flow regimes due to the apportionment may potentially impact gamefish spawning success and subsequent recruitment.

Studies of periphyton, macrobenthos and fish of the Poplar River have been conducted by Bahls (1977), Montana Department of Fish and Game (1976 and 1978), Saskmont Engineering (1978), the IJC (1979) and DeSimone (1980). The results of these studies provide for a general discussion of the aquatic biology of the river which is included as Appendix A-7.

4.9 METEOROLOGY AND AIR QUALITY

4.9.1 Meteorology

The climate of the Poplar River Basin is controlled largely by high pressure areas which move into the area from the north during the winter and from the west during the summer. The major tracks of low pressure centers pass either to the north or south of the area throughout the year. The area is in the rain shadow of the Rocky Mountains, resulting in a semiarid climate with a large annual range in temperature. Cold winters and warm summers are characteristics of the regional climate. The average monthly temperature at Scobey is above freezing between April and October. Detailed temperature data are presented in Appendix A-8.

The precipitation at Scobey ranged from a low of 7 inches to a high of 21.9 inches for the period 1940 to 1978. The average precipitation at Scobey from 1941 to 1970 is 13.6 inches. Monthly precipitation for Scobey is shown in Figure 4.9-1. While the normal annual precipitation for the area is only 11 to 14 inches, 76 percent of it falls from April through September, with May and June accounting for 34 percent of the annual total. Winter precipitation nearly always falls as snow. Although snow seldom accumulates to any great depth, it usually is formed into drifts in the open, unprotected areas. Accumulated winter snow remains on the ground until about March.

Wind plays an important role in the dispersion and dilution of pollutants emitted into the atmosphere. Pollutant concentrations are inversely proportional to wind speeds, i.e., the stronger the wind the lower the pollutant concentrations. The Poplar River Basin is characterized by relatively high winds and few periods of calm. Mean monthly wind speeds at Scobey typically range from 8 to 13 knots with calm winds occurring from 0.5 to 6 percent of the time on an annual basis. The higher wind speeds occur in the autumn and spring months from the northwest. The prevailing winds at Scobey are from the northwest or southeast. Wind rose plots are included in Appendix B-1 for Scobey and Glasgow, Montana.

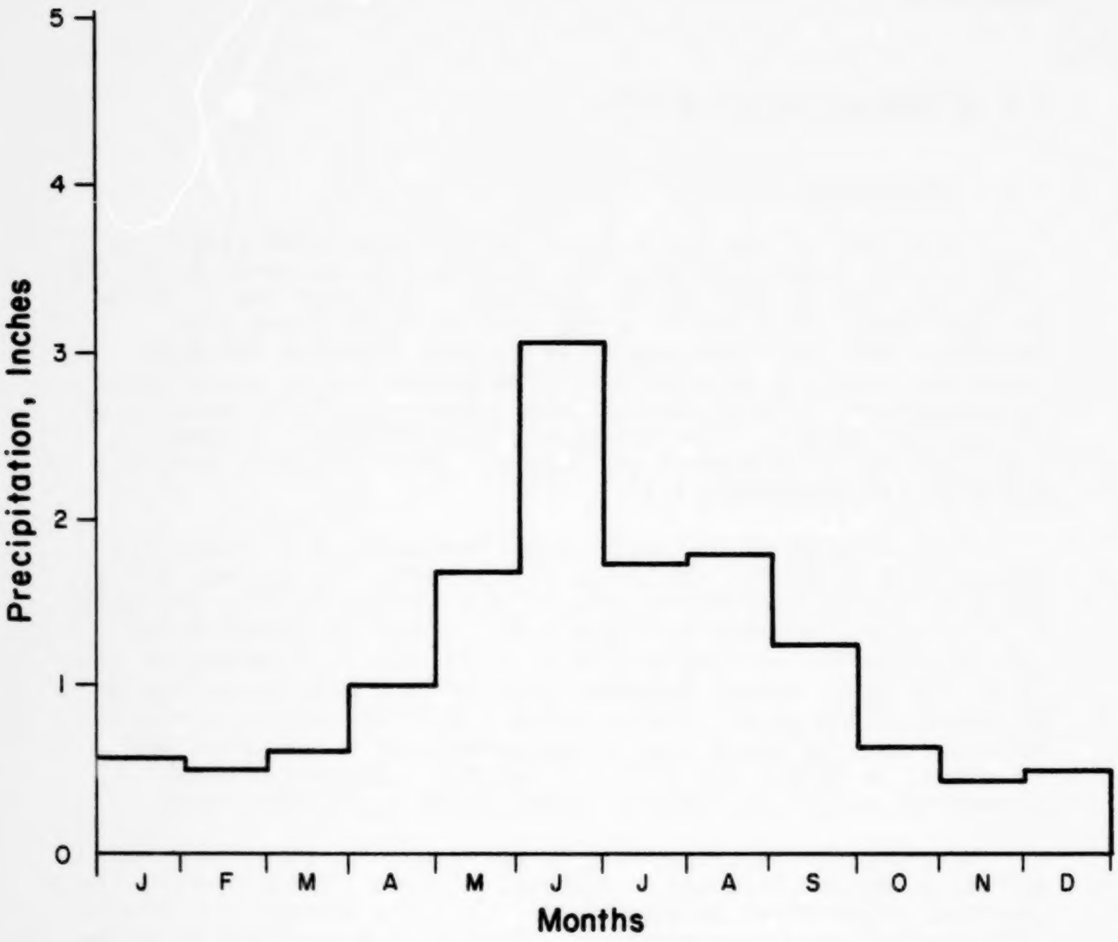


Figure 4.9-1 Normal Monthly Precipitation at Scobey, Montana

4.9.2 Existing Air Quality

The existing air quality in the study and impact area is very good. Recent measurements taken by the Montana Air Quality Bureau, during 1979, in northeastern Montana have shown very low concentrations of SO_2, NO_2 and particulates (Gelhaus, 1977, 1979). Since there are no major sources of pollutant emissions in northeastern Montana, these results might have been anticipated. A comparison of these values with the National and Montana ambient air quality standards shows that SO_2, NO_x and suspended particulates concentrations are well below standards. A further discussion of existing air quality and air quality standards in included in Appendix A-8.

4.10 SOCIAL AND ECONOMIC PROFILES

4.10.1 Population Profile

The population and average annual percentage change in population between 1970 and 1975 are shown for Daniels and Roosevelt counties in Table 4.10-1. Population has changed very little in Daniels County, remaining stable at about 3,100 throughout the five-year period, 1970-1975. Slight variations in population shown in Table 4.10-1 were due to changes in estimating procedure rather than actual changes in population. The size of the population also remained stable in Roosevelt County. There were approximately 10,300 people living in the county between 1970 and 1975 (see Table 4.10-1). The occasional fluctuations are due either to estimating techniques or to actual small population changes. Detailed population profiles by age, sex, and race are included in Appendix A-9.

The total population on the Fort Peck Indian Reservation was 9,898 in 1970. Indians made up 34 percent of the population, or 3,406. The number of Indians almost doubled in a three-year period to 6,202 in March, 1973.

Small population increases are projected for Daniels and Roosevelt counties. In Daniels County, between 1980 and the year 2000 an increase of 300 persons is projected, increasing the population from 3,100 to 3,400. The increase will be largely due to the construction and operation of a proposed potash plant which is projected to begin in about 1990. In Roosevelt County, the population is expected to increase from 10,700 to 11,500 between 1980 and 2000. The increase in employment due to oil and gas industries and exploration will increase the county population and counteract the declining agricultural opportunities (Montana Department of Community Affairs, 1978).

Table 4.10-1

POPULATION IN DANIELS AND ROOSEVELT COUNTIES, 1970-1975, AND PERCENTAGE CHANGE, 1970-1975

County	1970	1971	1972	1973	1974	1975	Average Annual Percent Change 1970 - 1975
Daniels	3,083[1]	3,000[2]	3,100[3]	3,100[1]	3,200[1]	3,100[4]	0.1%
Roosevelt	10,365[1]	10,400[2]	10,600[3]	10,300[1]	10,500[1] p	10,300[4] p	-0.1%

Sources:

[1] Bureau of the Census, Current Population Reports, Federal-State Cooperative Program for Population Estimates, Series P-26, No. 109, May, 1975.

[2] Bureau of the Census, Current Population Reports, Population Estimates and Projections, Series P-25, No. 517, May, 1974.

[3] Bureau of the Census, Current Population Reports, Federal-State Cooperative Program for Population Estimates, Series P-26, No. 53, February, 1974.

[4] Ibid, Series P-26, No. 76-26, July, 1977.

p = preliminary

4.10.2 Archaeological and Historical Sites

There have been no archaeological sites identified in Daniels County to date. However, the county is rated as having high future archaeological potential. Seven archaeological sites of various types have been identified within Roosevelt County. The county is also rated as having a high future archaeological potential.

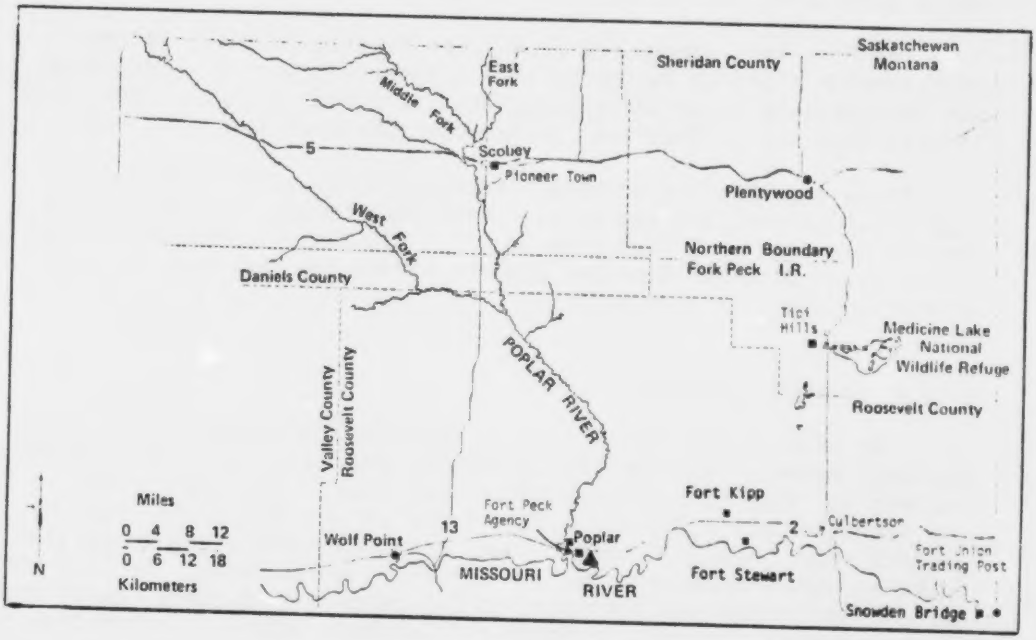
There are no national registered historical sites within Daniels County. However, within Scobey there is a private historical site, Pioneer Town. It is a representative pioneer homesteader town of the early 1900's that has been created by combining many authentic early structures and objects from throughout the county.

The Fort Peck Agency and Fort Union Trading Post are national registered historical landmarks within Roosevelt County. Fort Peck was originally a fur-trading post, then an Indian Agency. Fort Union Trading Post was an important early upper-Missouri fur trade depot.

There are also six private historical sites within the county, four of which were trading posts. Fort Jackson and Fort Poplar are located near Poplar. Fort Kipp and Fort Stewart are located west of Culbertson. Disaster Bend and Snowden Bridge are the other private historical sites (Figure 4.10-1).

4.10.3 Economic Profile

The size of the labor forces in Daniels and Roosevelt counties declined between 1960 and 1970; however, both counties have experienced increasing labor forces since 1972. The size of the labor force in 1975 was approximately 1,351 and 4,628 in Daniels and Roosevelt counties, respectively. The 1975 unemployment rates in Daniels and Roosevelt counties were 2.5 percent and 6.9 percent, respectively. By 1977 the unemployment rates had increased to 2.9 percent in Daniels County and decreased to 5.1 percent in Roosevelt County. Detailed information on employment rates, income and business activities are included in Appendix A-9.


Saskatchewan
Montana
Sheridan County
East Fork
Middle Fork
5
Scobey
Pioneer Town
Plentywood
West Fork
Daniels County
Northern Boundary Fork Peck I.R.
Tipi Hills
Medicine Lake National Wildlife Refuge
POPLAR RIVER
Valley County
Roosevelt County
Roosevelt County
Miles
0 4 8 12
0 6 12 18
Kilometers
N
Fort Peck Agency
13
Wolf Point
Poplar
MISSOURI
RIVER
Fort Kipp
2
Culbertson
Fort Stewart
Fort Union Trading Post
Snowden Bridge

■ Historic Places

● National Park Service Areas

▲ Location of Disaster Bend, Fort Jackson and Fort Poplar

Figure 4.10-1 LOCATION OF HISTORIC SITES IN THE POPLAR RIVER BASIN AND ADJACENT AREAS

5. ENVIRONMENTAL CONSEQUENCES

5.1 AIR QUALITY IMPACTS

5.1.1 Air Quality Model

To estimate the projected air pollution concentrations in the "impact area", the Environmental Protection Agency air quality Single-Source (CRSTER) Model was selected. This model was employed because it was determined that the Poplar River Power Plant would be the only significant contributor to the pollutant burden in the impact area through the year 2000. This model is also suitable to the flat or slightly rolling terrain which is found in the impact area.

The Single Source (CRSTER) Model is a steady-state Gaussian plume dispersion model designed for point-source applications. It calculates pollutant concentrations for each hour of a year at 180 receptor sites on a radial grid. The hourly concentrations are averaged to obtain concentration estimates for time increments of specified length, such as 3-hour, 8-hour, 24-hour and annual. The model contains the concentration equations, the Pasquill-Gifford dispersion coefficients and the Pasquill stability classes. Plume rise is calculated according to Briggs. No depletion of the pollutant is considered. A complete description of the model is presented in Appendix C.

5.1.2 Power Plant Emissions

The emission rates for the power plant were obtained from the U.S. Environmental Protection Agency (EPA) Regional Office in Denver, Colorado. The following emission rates were employed in the model.

Pollutant	Emission Rate for 600 MW Plant (pounds/hour)	Emission Rate for 600 MW Plant (g/second)
Sulfur Dioxide (SO_2)	10,732	1352.2
Particulate (TSP)	450	56.7
Oxides of Nitrogen (NO_x)	3,600	453.6

The emission rates are for a 600 MW plant with a single stack. The SO_2 emission rate was calculated on the basis of 1.94 pound $SO_2/10^6$ Btu heat input and about 8 percent sulfur retention. The particulate emissions employed 99.5 percent control and 0.08 pounds/10^6 Btu. The NO_x emissions utilized a 0.60 pound/10^6 Btu rate. The EPA new source performance standards for SO_2, TSP, and NO_x are 1.2, 0.10, and 0.70 pounds per 10^6 Btu, respectively.

5.1.3 Model Input Parameters

The emission rates employed in the model are shown in the previous section (5.1.2). The stack data that were employed for plume rise height computation were obtained from the EPA Regional Office in Denver and with one exception are in agreement with Appendix E Plant, Mine and Reservoir Operations (IJC, 1979). The diameter given in this report was 7.1 m. The parameters are as follows:

Stack Data for 600 MW Plant

- Number - 1
- Height, meters - 122.0 (121.9)
- Diameter, meters - 7.4 (7.1)
- Exit velocity, meters/sec - 24.4 (24.2)
- Exit temperature, ^{o}K - 424 (425.2)

The values in parentheses are the data used in the later modeling work by the Montana Air Quality Bureau (Gelhaus, 1980).

The model was run twice--once using meteorological data from Glasgow and once using the recently collected data from Scobey. The meteorological data from Glasgow, Montana were hourly surface observations and twice daily mixing heights for the year 1964. The year 1960 was also employed to determine if there were any significant differences in peak concentrations of pollutants for the two years since temperature and wind conditions were quite different during the months of January and February. The mean temperatures for these months were 10 to 15 degrees colder, and the frequency of calms was about seven percent higher in 1960 than in 1964. The meteorological data were obtained on magnetic tape from the National Climatic Center in Asheville, North Carolina. The data from Scobey were obtained from the new continuous meteorological monitoring station for the period November 1, 1978, through October 31, 1979. Meteorological data at Scobey and Glasgow are shown in Appendix B.

5.1.4 Modeling Results

5.1.4.1 Sulfur Dioxide (SO_2)

For SO_2, the model was employed to obtain maximum concentrations and second highest concentrations in the impact area for averaging times of 1 hour, 3 hours, and 24 hours. The annual concentrations for the year were also obtained. Values were computed at 2 kilometer (km) intervals along 10° radials out to a distance of 50 kilometers from the plant site. Calculations were not made for greater distances, because the basic assumptions incorporated into the model cause the results to be suspect at greater distances. However, concentrations at distances greater than 50 kilometers should become less as the distance increases.

Spatial distributions of the highest maximum short term concentrations (1 hour, 3 hours, and 24 hours) and the 1964 annual concentrations are presented in Figures 5.1-1 through 5.1-4. The isopleths are labeled in ug/m^3 units of concentration. They represent resulting concentrations with zero percent emission controls. The basic labels are for a generating capacity of 600 MW because this is the most likely development, while those in parentheses are for a 1200 MW capacity. Operation of one 300 MW unit would result in predicted concentrations equal to one half of the 600 MW concentrations.

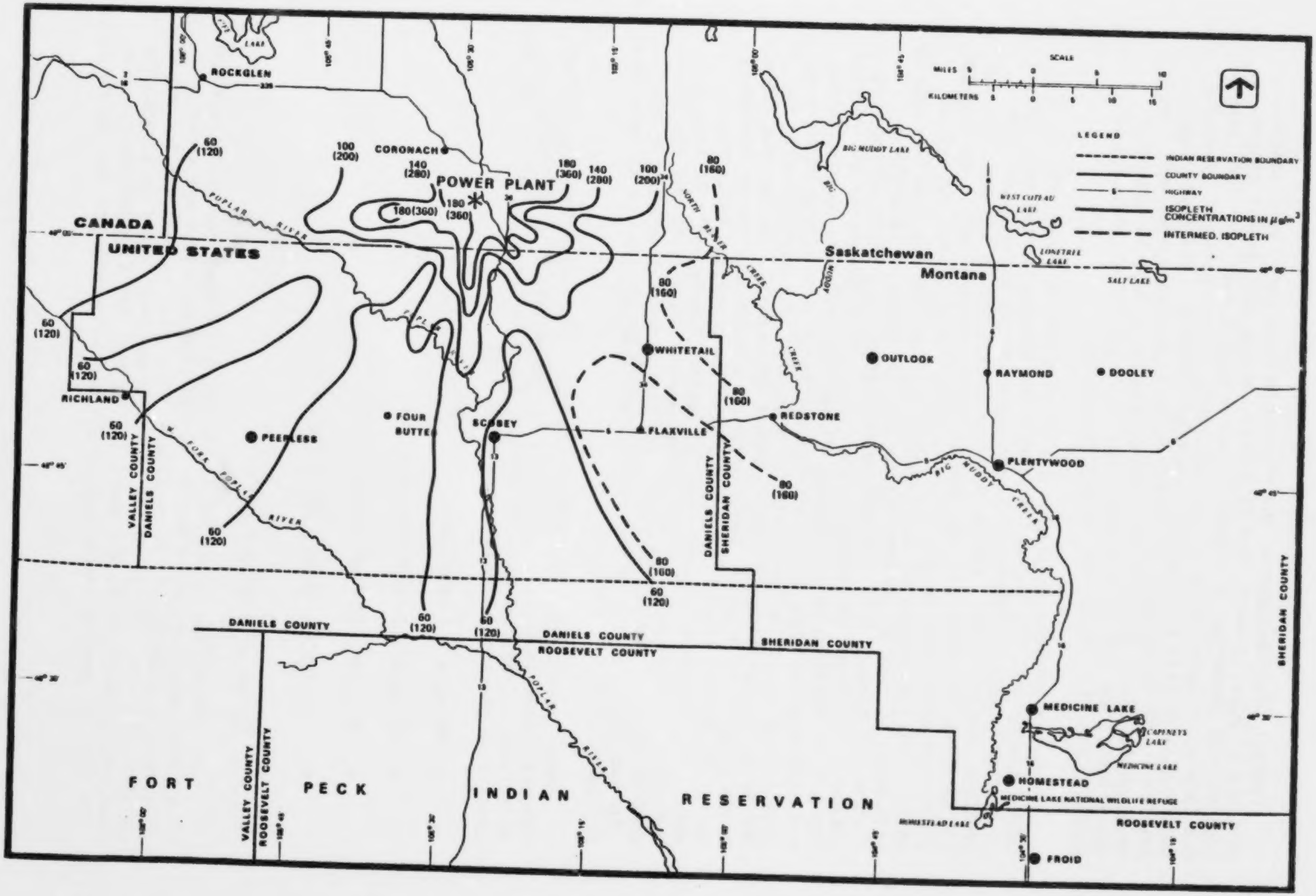
Both the tabular and graphical presentations of model results for 1964 indicate that the highest predicted SO_2 concentrations will occur in southerly and southeasterly directions from the plant site. The greatest 1-hour, 3-hour, and 24-hour concentrations in the U.S. for two 300 MW units are about 214, 96, and 28 ug/m^3, respectively. The highest annual concentrations in the U.S. are about 2.4 ug/m^3 for two 300 MW units. Detailed tables of model output for both 600 and 1200 MW capacity with zero, 60, and 90 percent SO_2 control are shown in Appendix C (Tables C-2 through C-7). Higher concentrations may occur during fumigation as discussed in Section 5.1.5.4, but these concentrations persist for a short duration only. Regions of maximum predicted concentrations are generally confined to the extreme northerly part of the impact area within 15 miles of the International Boundary. For example, with two 300 MW units operating with zero percent SO_2 control, the maximum annual concentrations (2.4 ug/m^3) would occur on azimuth 120° in the northeast corner of Daniels County (Figure 5.1-4). The predicted elevation in annual SO_2 concentrations for most of Daniels County would be less than 0.6 ug/m^3 (0.00023 ppm). Although Roosevelt County is beyond the predictive range of the CRSTER model, the annual SO_2 concentrations there (for two 300 MW units, no SO_2 control) would be expected to be less than 0.2 ug/m^3 (0.000076 ppm).

Model predictions for 1978-79 (Gelhaus, 1980) also indicate maximum concentrations in the U.S. occurring in southeasterly to southerly directions. Predicted maximum concentrations in the U.S. for two 300 MW units from these model results are as follows:

- 400 ug/m^3, 1-hour concentration
- 166 ug/m^3, 3-hour concentration
- 46 ug/m^3, 24-hour concentration
- 1.6 ug/m^3, annual concentration.

5.1.4.2 Oxides of Nitrogen (NO_x)

The spatial distributions of the highest 1-hour concentrations and the annual mean concentrations of NO_x for the year 1964 are shown in Figures 5.1-5 and 5.1-6, respectively. The general patterns for the NO_x distribution are similar to the SO_2 distributions. This is because the meteorological input to the model is the same for both pollutants. In the U.S. the maximum 1-hour and annual concentrations for two 300 MW units



SCALE
MILES
KILOMETERS
LEGEND
INDIAN RESERVATION BOUNDARY
COUNTY BOUNDARY
HIGHWAY
ISOPLETH CONCENTRATIONS IN μg/m³
INTERMED. ISOPLETH
CANADA
UNITED STATES
Saskatchewan
Montana
POWER PLANT
ROCKGLEN
CORONACH
RICHLAND
PEERLESS
FOUR BUTTE
SCOBEY
WHITETAIL
FLAXVILLE
REDSTONE
OUTLOOK
RAYMOND
DOOLEY
PLENTYWOOD
MEDICINE LAKE
HOMESTEAD
FROID
POPLAR RIVER
W. FORK POPLAR RIVER
BIG MUDDY CREEK
BIG MUDDY LAKE
WEST CUTEAU LAKE
LONETREE LAKE
SALT LAKE
NORTH BEAVER CREEK
MEDICINE LAKE NATIONAL WILDLIFE REFUGE
HOMESTEAD LAKE
VALLEY COUNTY
DANIELS COUNTY
SHERIDAN COUNTY
ROOSEVELT COUNTY
FORT PECK INDIAN RESERVATION
60 (120)
80 (160)
100 (200)
140 (280)
180 (360)

Figure 5.1-1 SPATIAL DISTRIBUTION OF THE HIGHEST 1-HOUR SO_2 CONCENTRATIONS ($\mu G/M^3$) OBTAINED FROM THE CRSTER MODEL FOR 1964, ASSUMING A 600 MW (1200 MW) POPLAR RIVER POWER PLANT WITH ZERO PERCENT EMISSION CONTROL

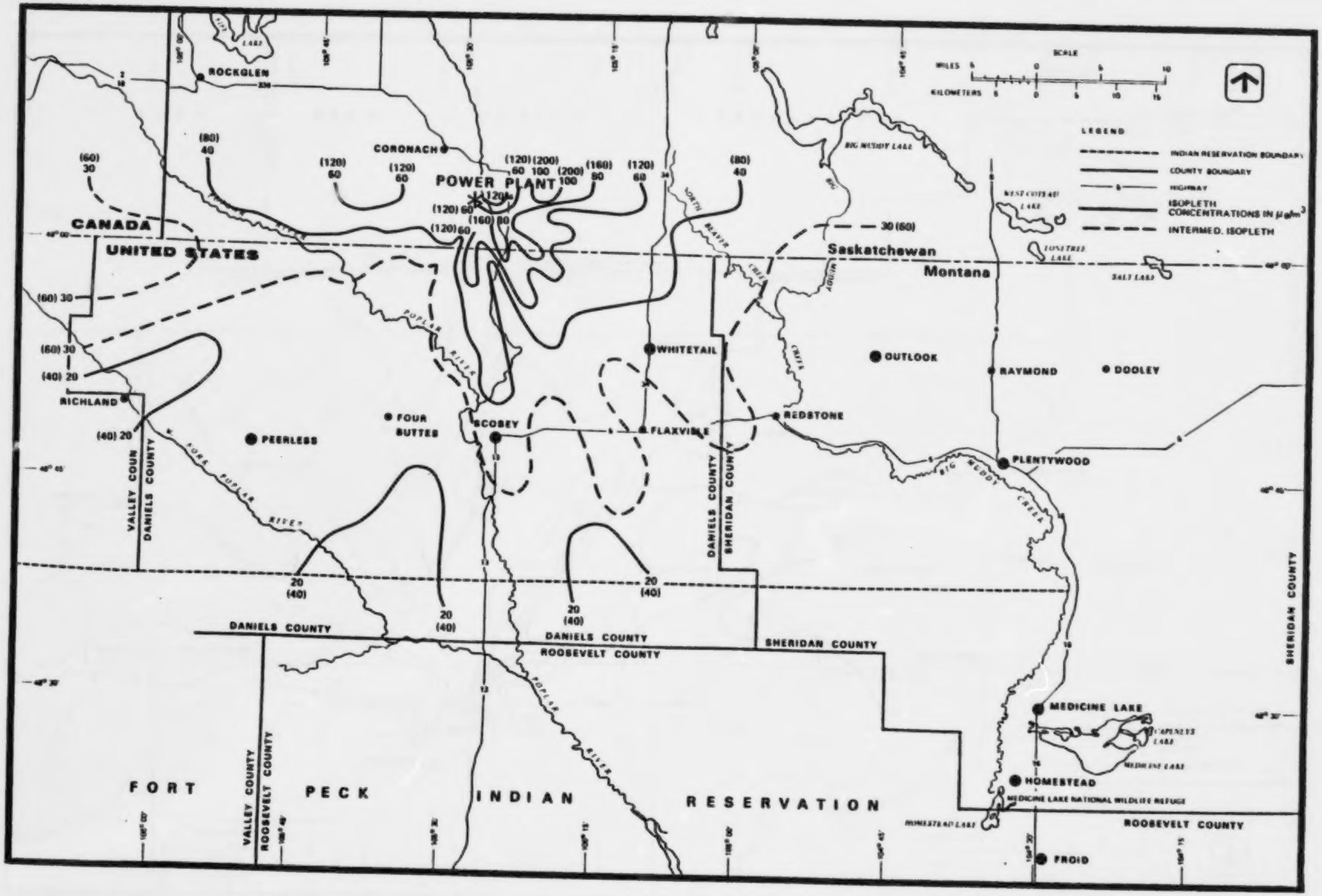

SCALE
MILES
KILOMETERS
LEGEND
INDIAN RESERVATION BOUNDARY
COUNTY BOUNDARY
HIGHWAY
ISOPLETH CONCENTRATIONS IN $\mu g/m^3$
INTERMED. ISOPLETH
CANADA
UNITED STATES
Saskatchewan
Montana
POWER PLANT
ROCKGLEN
CORONACH
WHITETAIL
OUTLOOK
RAYMOND
DOOLEY
REDSTONE
FLAXVILLE
SCOBEY
FOUR BUTTES
PEERLESS
RICHLAND
PLENTYWOOD
MEDICINE LAKE
HOMESTEAD
FROID
MEDICINE LAKE NATIONAL WILDLIFE REFUGE
HOMESTEAD LAKE
BIG MUDDY LAKE
WEST COTEAU LAKE
LONETREE LAKE
SALT LAKE
BIG MUDDY CREEK
POPLAR RIVER
W. FORK POPLAR RIVER
NORTH BEAVER CREEK
VALLEY COUNTY
DANIELS COUNTY
SHERIDAN COUNTY
ROOSEVELT COUNTY
FORT PECK INDIAN RESERVATION
(60) 30
(80) 40
(120) 60
(120) 60
(120)(200) 60 100
(200) 100
(160) 80
(120) 60
(80) 40
(1200)
(120) 60
(160) 80
(120) 60
30 (60)
(60) 30
(60) 30
(40) 20
(40) 20
20 (40)
20 (40)
20 (40)
20 (40)

Figure 5.1-2 SPATIAL DISTRIBUTION OF THE HIGHEST 3-HOUR SO_2 CONCENTRATIONS ($\mu G/M^3$) OBTAINED FROM THE CRSTER MODEL FOR 1964, ASSUMING A 600 MW (1200 MW) POPLAR RIVER POWER PLANT WITH ZERO PERCENT EMISSION CONTROL

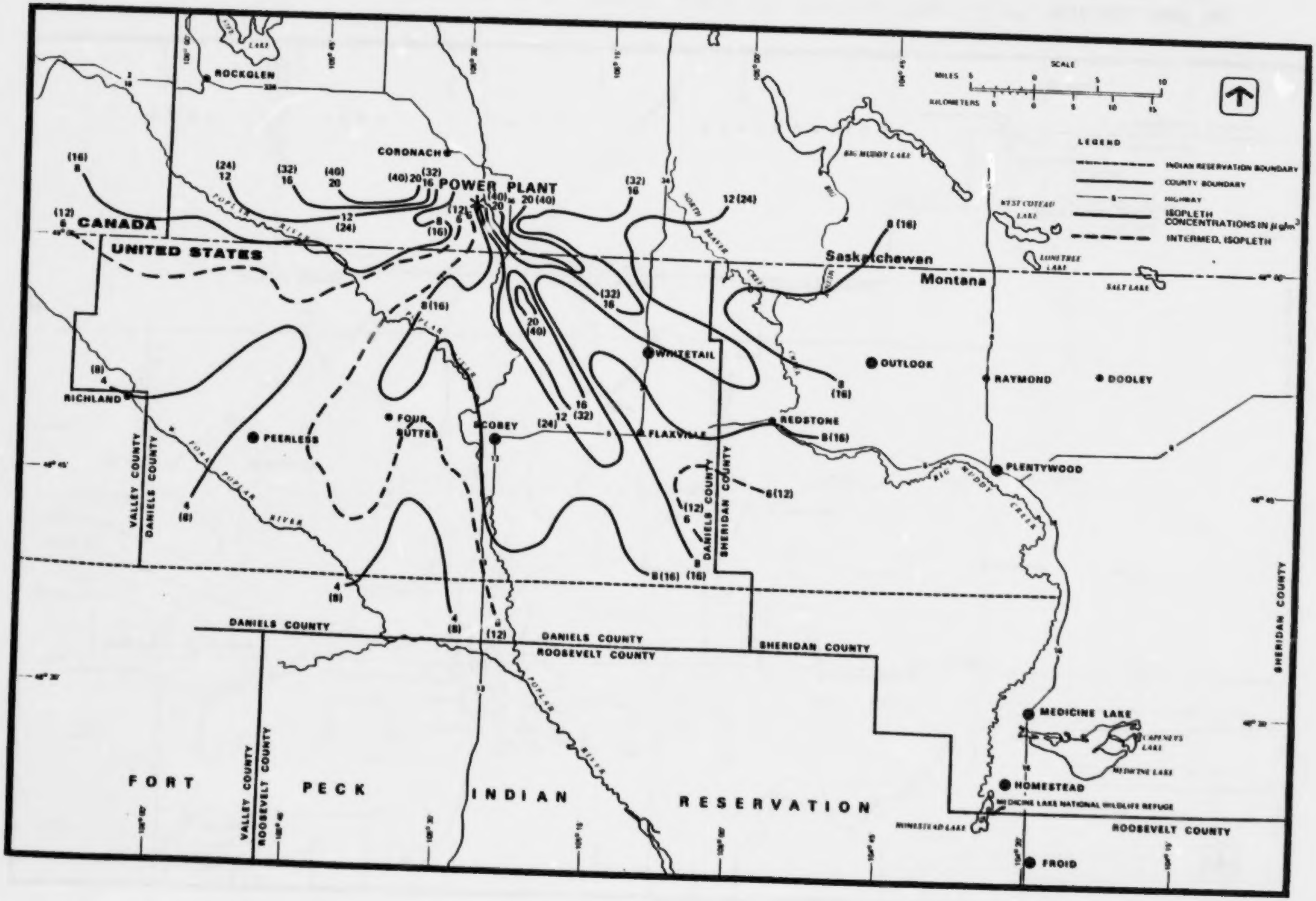

SCALE
MILES 5 0 5 10
KILOMETERS 5 0 5 10 15
LEGEND
INDIAN RESERVATION BOUNDARY
COUNTY BOUNDARY
HIGHWAY
ISOPLETH CONCENTRATIONS IN μg/m³
INTERMED. ISOPLETH
POWER PLANT
CANADA
UNITED STATES
Saskatchewan
Montana
ROCKGLEN
CORONACH
WHITETAIL
OUTLOOK
RAYMOND
DOOLEY
REDSTONE
FLAXVILLE
SCOBEY
FOUR BUTTES
PEERLESS
RICHLAND
PLENTYWOOD
MEDICINE LAKE
HOMESTEAD
FROID
MEDICINE LAKE NATIONAL WILDLIFE REFUGE
VALLEY COUNTY
DANIELS COUNTY
SHERIDAN COUNTY
ROOSEVELT COUNTY
FORT PECK INDIAN RESERVATION
POPLAR RIVER
BIG MUDDY CREEK
NORTH BEAVER CREEK
BIG MUDDY LAKE
WEST COTEAU LAKE
LONGTREE LAKE
SALT LAKE

Figure 5.1-3 SPATIAL DISTRIBUTION OF THE HIGHEST 24-HOUR SO_2 CONCENTRATIONS ($\mu G/M^3$) OBTAINED FROM THE CRSTER MODEL FOR 1964, ASSUMING A 600 MW (1200 MW) POPLAR RIVER POWER PLANT WITH ZERO PERCENT EMISSION CONTROL

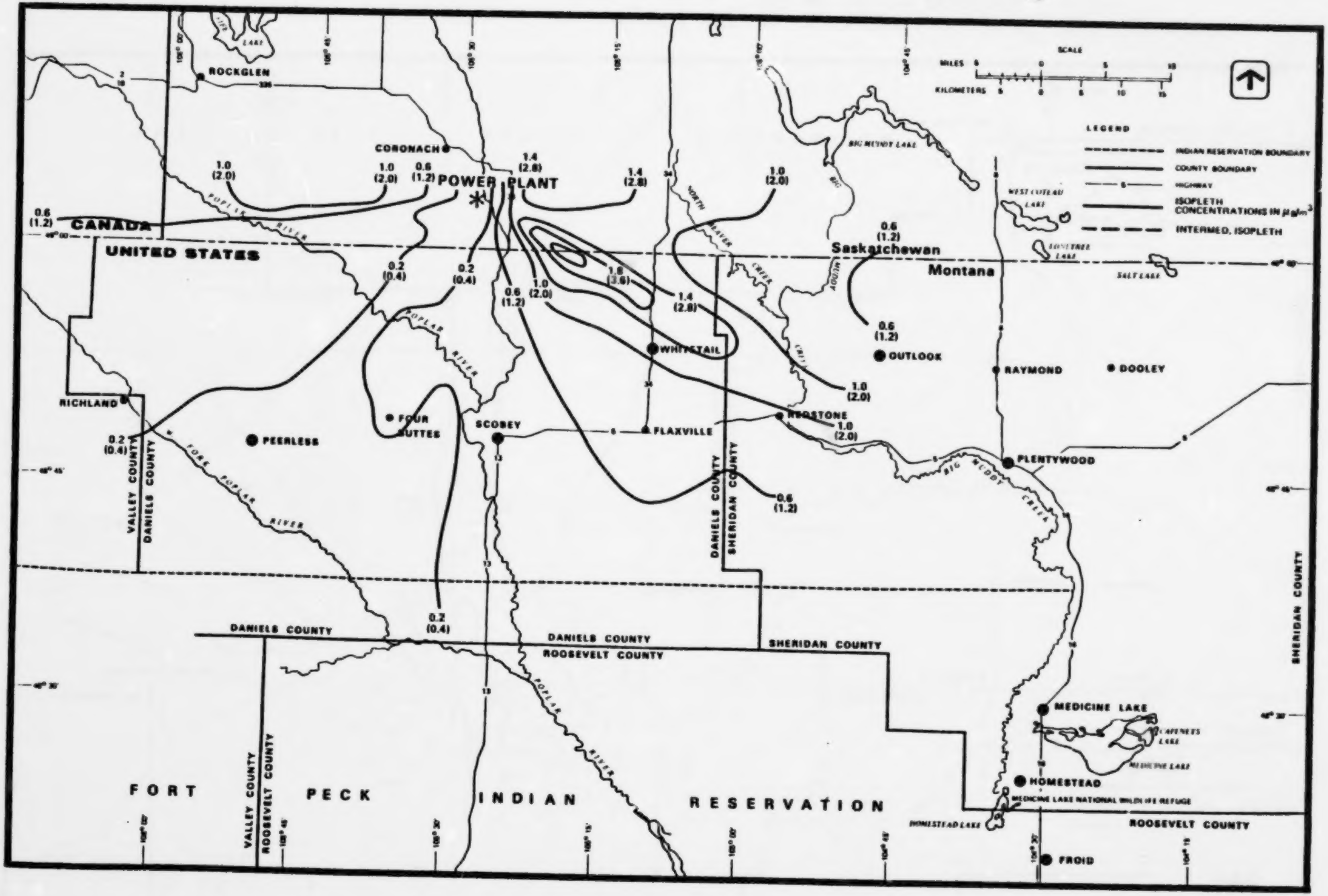

SCALE
MILES 5 0 5 10
KILOMETERS 5 0 5 10 15
LEGEND
INDIAN RESERVATION BOUNDARY
COUNTY BOUNDARY
HIGHWAY
ISOPLETH CONCENTRATIONS IN μg/m³
INTERMED. ISOPLETH
ROCKGLEN
CORONACH
POWER PLANT
CANADA
UNITED STATES
Saskatchewan
Montana
POPLAR RIVER
1.0 (2.0)
0.6 (1.2)
1.4 (2.8)
1.8 (3.6)
0.2 (0.4)
WHITETAIL
OUTLOOK
RAYMOND
DOOLEY
REDSTONE
FLAXVILLE
SCOBEY
FOUR BUTTES
PEERLESS
RICHLAND
PLENTYWOOD
BIG MUDDY CREEK
BIG MUDDY LAKE
NORTH BEAVER CREEK
WEST COTEAU LAKE
LONETREE LAKE
SALT LAKE
W. FORK POPLAR RIVER
VALLEY COUNTY
DANIELS COUNTY
SHERIDAN COUNTY
ROOSEVELT COUNTY
MEDICINE LAKE
HOMESTEAD
MEDICINE LAKE NATIONAL WILDLIFE REFUGE
HOMESTEAD LAKE
FROID
FORT PECK INDIAN RESERVATION
106° 00'
105° 45'
105° 30'
105° 15'
105° 00'
104° 45'
104° 30'
104° 15'
49° 00'
48° 45'
48° 30'

Figure 5.1-4 SPATIAL DISTRIBUTION OF THE 1964 ANNUAL SO_2 CONCENTRATIONS ($\mu G/M^3$) OBTAINED FROM THE CRSTER MODEL, ASSUMING A 600 MW (1200 MW) POPLAR RIVER POWER PLANT WITH ZERO PERCENT EMISSION CONTROL

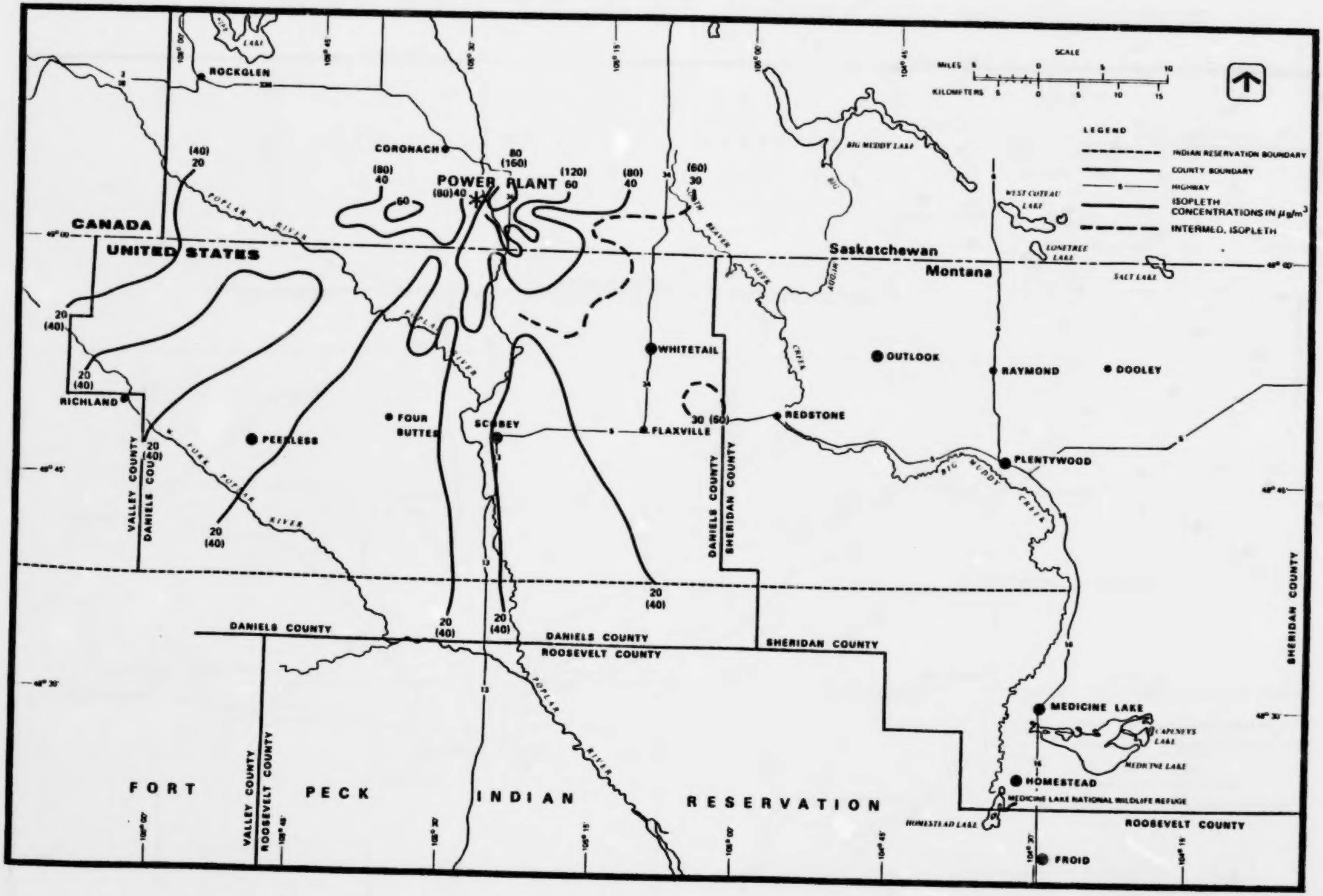

SCALE
MILES 5 0 5 10
KILOMETERS 5 0 5 10 15
LEGEND
INDIAN RESERVATION BOUNDARY
COUNTY BOUNDARY
HIGHWAY
ISOPLETH CONCENTRATIONS IN μg/m3
INTERMED. ISOPLETH
CANADA
UNITED STATES
Saskatchewan
Montana
POWER PLANT
ROCKGLEN
CORONACH
WHITETAIL
FLAXVILLE
OUTLOOK
RAYMOND
DOOLEY
REDSTONE
PLENTYWOOD
SCOBEY
FOUR BUTTES
PEERLESS
RICHLAND
MEDICINE LAKE
HOMESTEAD
FROID
POPLAR RIVER
W. FORK POPLAR RIVER
BIG MUDDY CREEK
BIG MUDDY LAKE
WEST COTEAU LAKE
LONETREE LAKE
SALT LAKE
MEDICINE LAKE NATIONAL WILDLIFE REFUGE
HOMESTEAD LAKE
VALLEY COUNTY
DANIELS COUNTY
SHERIDAN COUNTY
ROOSEVELT COUNTY
FORT PECK INDIAN RESERVATION
80 (160)
(120) 60
(80) 40
(60) 30
(80)40
60
30 (60)
20 (40)
49° 00'
48° 45'
48° 30'
106° 00'
105° 45'
105° 30'
105° 15'
105° 00'
104° 45'
104° 30'
104° 15'

Figure 5.1-5 SPATIAL DISTRIBUTION OF THE HIGHEST 1-HOUR NO_x CONCENTRATIONS ($\mu G/M^3$) OBTAINED FROM THE CRSTER MODEL FOR 1964, ASSUMING A 600 MW (1200 MW) POPLAR RIVER POWER PLANT

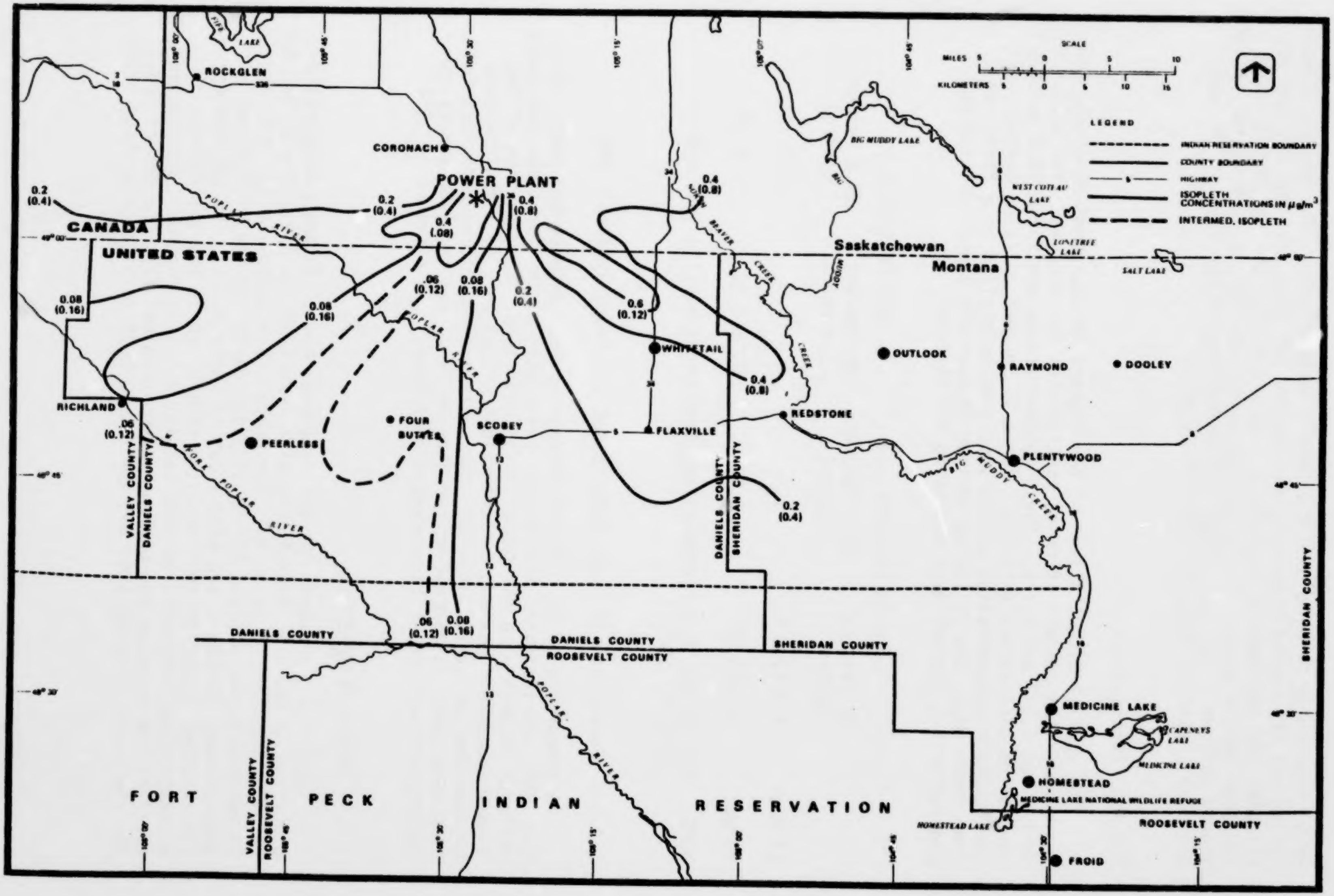

SCALE
MILES 5 0 5 10
KILOMETERS 5 0 5 10 15
LEGEND
INDIAN RESERVATION BOUNDARY
COUNTY BOUNDARY
HIGHWAY
ISOPLETH CONCENTRATIONS IN $\mu g/m^3$
INTERMED. ISOPLETH
POWER PLANT
CANADA
UNITED STATES
Saskatchewan
Montana
ROCKGLEN
CORONACH
RICHLAND
PEERLESS
FOUR BUTTES
SCOBEY
WHITETAIL
FLAXVILLE
REDSTONE
OUTLOOK
RAYMOND
DOOLEY
PLENTYWOOD
MEDICINE LAKE
HOMESTEAD
FROID
BIG MUDDY LAKE
WEST COTEAU LAKE
LONETREE LAKE
SALT LAKE
FIFE LAKE
CAPENEYS LAKE
MEDICINE LAKE
MEDICINE LAKE NATIONAL WILDLIFE REFUGE
HOMESTEAD LAKE
POPLAR RIVER
W. FORK POPLAR RIVER
BEAVER CREEK
BIG MUDDY CREEK
VALLEY COUNTY
DANIELS COUNTY
SHERIDAN COUNTY
ROOSEVELT COUNTY
FORT PECK INDIAN RESERVATION
0.2 (0.4)
0.4 (.08)
0.4 (0.8)
0.6 (0.12)
0.08 (0.16)
.06 (0.12)
49° 00'
48° 45'
48° 30'
106° 00'
105° 45'
105° 30'
105° 15'
105° 00'
104° 45'
104° 30'
104° 15'

Figure 5.1-6 SPATIAL DISTRIBUTION OF THE 1964 ANNUAL NO_x CONCENTRATIONS ($\mu G/M^3$) OBTAINED FROM THE CRSTER MODEL, ASSUMING A 600 MW (1200 MW) POPLAR RIVER POWER PLANT

of NO_x are about 74 ug/m^3 and 0.8 ug/m^3, respectively. The highest 1-hour maxima and the second highest 1-hour maxima for 120, 170, and 260 degree aximuths are included in Appendix C, Table C-8, for the two 300 MW units and four 300 MW units. Predicted concentrations for 1978-79 (Gelhaus, 1980) showed maximum 1-hour and annual concentrations in the U.S. of 134 and 0.6 ug/m^3, respectively, for two 300 MW units.

5.1.4.3 Particulates

The spatial distributions of the highest 24-hour concentrations and the annual mean concentration of particulates for the year 1964 are shown in Figures 5.1-7 and 5.1-8. These concentrations are for a 99.5 percent controlled particulate emission. For a 99 percent emission control, all the isopleth concentration values should be multiplied by a factor of 2. From these maps, the following maximum 24-hour and annual particulate concentrations (ug/m^3) were estimated for Montana:

	600 MW Capacity		1200 MW Capacity	
	99 Percent Control	99.5 Percent Control	99 Percent Control	99.5 Percent Control
24 hour	2.0 (2.0)	1.0	4.0 (4.0)	0.18
Annual	0.18(0.06)	0.09	0.36(0.12)	0.18

NOTE: The values in parentheses are from model results for 1978-79 (Gelhaus, 1980).

5.1.4.4 Comparison of Model Outputs for the Years 1964 and 1960

A comparison of SO_2 concentrations was made between the years 1964 and 1960. As indicated previously, the winter months for these two years differed in both wind and temperature conditions. A comparison of the 1-hour and 3-hour maximum concentrations showed very little difference between the two years. However, the maximum 24-hour concentrations in 1960 were about 31 percent higher than in 1964, and the 1960 annual concentrations were about 10 percent higher than those obtained in 1964.

5.1.5 Impact Assessment

Table 5.1-1 presents the estimated maximum pollutant concentrations occurring in the U.S. impact area as a result of the operation of two 300 MW units or four 300 MW units. For comparative purposes, the U.S. and Canadian National Ambient Air Quality Standards and the Montana and Saskatchewan standards are also shown in Table 5.1-1. The SO_2 concentrations assume a zero percent emission control while the particulate concentrations are based on a 99 percent emission control. The concentrations are based on the maximum values obtained from the CRSTER Model for the years 1960 and 1964 and for the 1978-79 results of Gelhaus (1980).

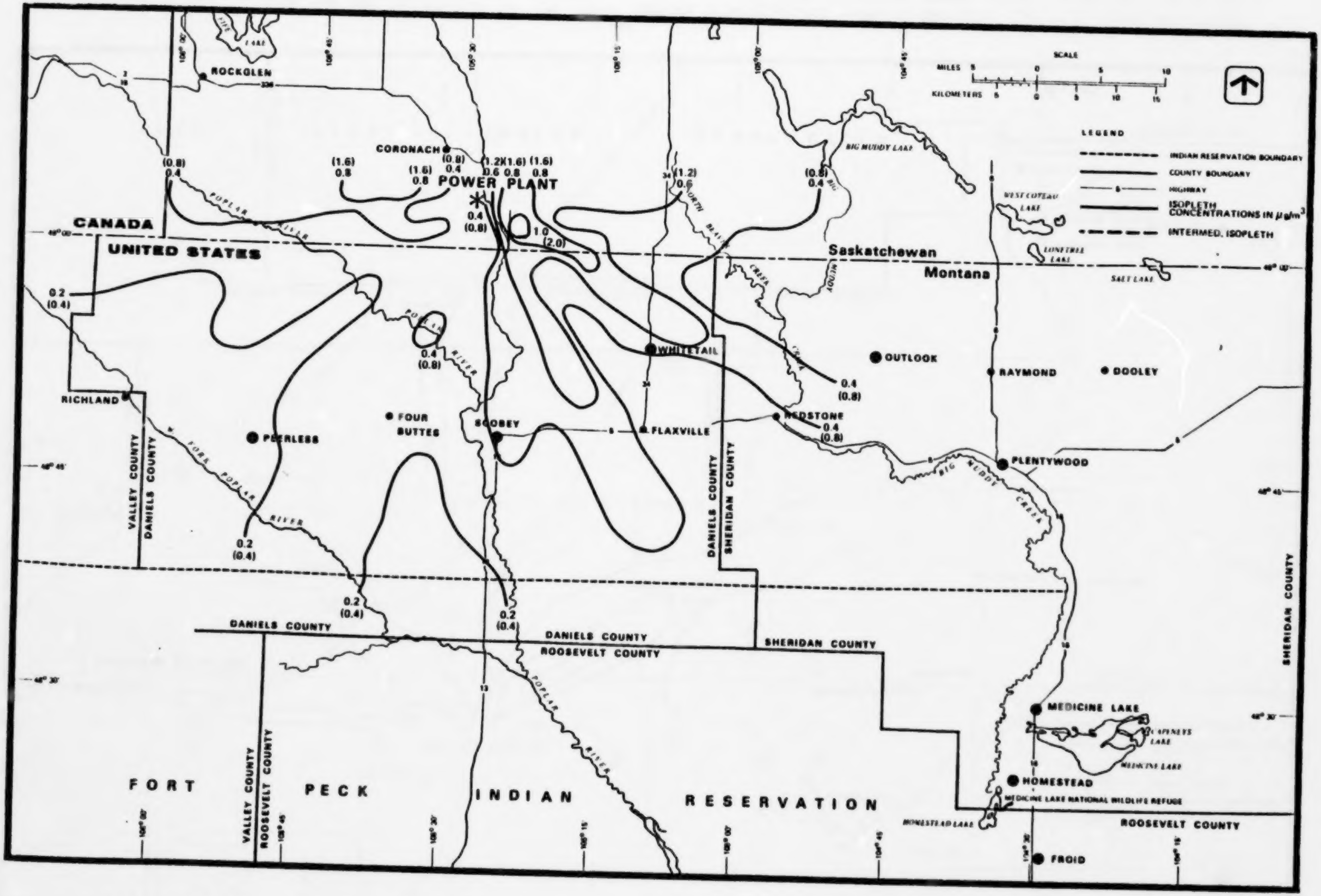

SCALE
MILES 5 0 5 10
KILOMETERS 5 0 5 10 15
LEGEND
INDIAN RESERVATION BOUNDARY
COUNTY BOUNDARY
HIGHWAY
ISOPLETH CONCENTRATIONS IN μg/m^3
INTERMED. ISOPLETH
CANADA
UNITED STATES
Saskatchewan
Montana
POWER PLANT
CORONACH
ROCKGLEN
WHITETAIL
FLAXVILLE
SCOBEY
FOUR BUTTES
PEERLESS
RICHLAND
REDSTONE
OUTLOOK
RAYMOND
DOOLEY
PLENTYWOOD
MEDICINE LAKE
HOMESTEAD
FROID
POPLAR RIVER
BIG MUDDY CREEK
BIG MUDDY LAKE
MEDICINE LAKE NATIONAL WILDLIFE REFUGE
HOMESTEAD LAKE
DANIELS COUNTY
SHERIDAN COUNTY
ROOSEVELT COUNTY
VALLEY COUNTY
FORT PECK INDIAN RESERVATION
(1.6) 0.8
(0.8) 0.4
(1.2)(1.6) 0.6 0.8
0.4 (0.8)
1.0 (2.0)
0.2 (0.4)

Figure 5.1-7 SPATIAL DISTRIBUTION OF THE HIGHEST 24-HOUR PARTICULATE CONCENTRATIONS (μG/M^3) OBTAINED FROM THE CRSTER MODEL FOR 1964, ASSUMING A 600 MW (1200 MW) POPLAR RIVER POWER PLANT WITH 99.5 PERCENT EMISSION CONTROL

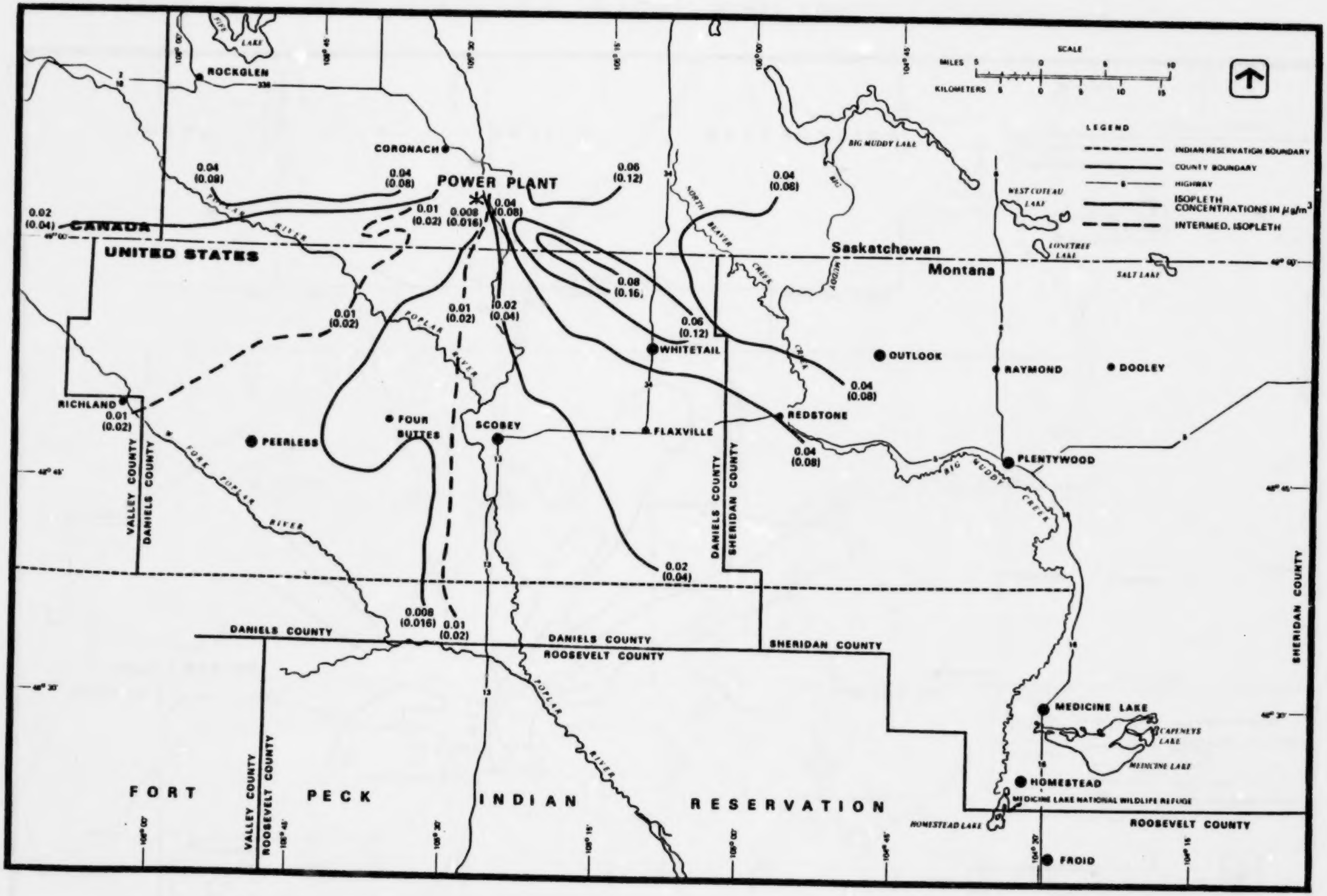

SCALE
MILES 5 0 5 10
KILOMETERS 5 0 5 10 15
LEGEND
INDIAN RESERVATION BOUNDARY
COUNTY BOUNDARY
HIGHWAY
ISOPLETH CONCENTRATIONS IN μg/m³
INTERMED. ISOPLETH
POWER PLANT
CANADA
UNITED STATES
Saskatchewan
Montana
ROCKGLEN
CORONACH
WHITETAIL
OUTLOOK
RAYMOND
DOOLEY
REDSTONE
FLAXVILLE
SCOBEY
FOUR BUTTES
PEERLESS
RICHLAND
PLENTYWOOD
MEDICINE LAKE
HOMESTEAD
FROID
BIG MUDDY LAKE
WEST COTEAU LAKE
LONETREE LAKE
SALT LAKE
FIFE LAKE
NORTH BEAVER CREEK
BIG MUDDY CREEK
POPLAR RIVER
FORK POPLAR RIVER
CAPENEYS LAKE
MEDICINE LAKE
MEDICINE LAKE NATIONAL WILDLIFE REFUGE
HOMESTEAD LAKE
VALLEY COUNTY
DANIELS COUNTY
SHERIDAN COUNTY
ROOSEVELT COUNTY
FORT PECK INDIAN RESERVATION
0.02 (0.04)
0.04 (0.08)
0.04 (0.08)
0.01 (0.02)
0.008 (0.016)
0.04 (0.08)
0.06 (0.12)
0.04 (0.08)
0.08 (0.16)
0.06 (0.12)
0.01 (0.02)
0.01 (0.02)
0.02 (0.04)
0.04 (0.08)
0.04 (0.08)
0.01 (0.02)
0.02 (0.04)
0.008 (0.016)
0.01 (0.02)
49° 00'
48° 45'
48° 30'
106° 00'
105° 45'
105° 30'
105° 15'
105° 00'
104° 45'
104° 30'
104° 15'
105° 45'

Figure 5.1-8 SPATIAL DISTRIBUTION OF THE 1964 ANNUAL PARTICULATE CONCENTRATIONS (μG/M³) OBTAINED FROM THE CRSTER MODEL, ASSUMING A 600 MW (1200 MW) POPLAR RIVER POWER PLANT WITH 99.5 PERCENT EMISSION CONTROL

Table 5.1-1

ESTIMATED MAXIMUM POLLUTANT CONCENTRATIONS IN MONTANA FROM THE POPLAR RIVER POWER PLANT

(Concentrations in micrograms per cubic meter)[a]

Pollutant	Time Period	Power Plant Size		NAAQS[b]	Montana AAQS	PSD Class II	MCD[c]	Sask[d] AAQS
		600 Mw	1200 Mw					
Sulfur Dioxide	1-hour	400 (214)[e]	800 (428)	--	1300	--	450	450
	3-hour	166 (96)	332 (192)	1300	--	512	--	--
	24-hour	46 (28)	92 (56)	365	265	91	150	150
	Annual	1.6 (2.4)	3.2 (4.8)	80	55	20	30	30
Nitrogen Oxides	1-hour	134 (74)	268 (148)	--	564	--	--	400
	Annual	0.6 (.79)	1.2 (1.6)	100	94	--	60	100
Particulates	24-hour	2.0 (2.6)	4.0 (5.2)	150[f]	200	37	--	120
	Annual	0.06 (.2)	0.12 (.4)	60[f]	75	19	60	70

[a] Note - higher concentrations have been predicted using a fumigation model. However, the duration time remains uncertain. SO_2 concentrations assume zero percent control; particulate concentrations assume 99 percent control.

[b] National Ambient Air Quality Standards

[c] Maximum Canadian Desirable Criteria

[d] Saskatchewan Ambient Air Quality Standards

[e] Numbers in parentheses are predicted concentrations in this document

[f] Secondary Standard

5.1.5.1 Sulfur Dioxide Impact

The SO_2 measurements made by the Montana Air Quality Bureau showed the 24-hour averaged SO_2 concentrations to be less than 6 ug/m^3. Both model predictions show that SO_2 concentrations for 1-hour, 3-hour, 24-hour and the annual mean are below U.S. and Montana ambient air quality standards. For example, the 24-hour SO_2 concentrations added to the background concentrations by four 300 MW units are about 56 ug/m^3. Thus, the total concentration of 82 ug/m^3 is well below the Montana AAQS of 265 ug/m^3, and the U.S. NAAQS of 365 ug/m^3. The highest 1-hour concentrations were estimated to be near 428 ug/m^3 for four 300 MW units by one modeling approach. This concentration is below the 655 ug/m^3 Montana AAQS but approaches the Saskatchewan standard of 450 ug/m^3. The prediction by Gelhaus (1980) of 800 ug/m^3 exceeds the Saskatchewan standard. The highest 3-hour concentrations and the annual concentrations are well below all air quality standards.

Although the SO_2 concentrations resulting from up to four 300 MW units are below U.S. and Montana standards this will result in some deterioration of air quality in the U.S. impact area. To prevent significant deterioration (PSD) of air quality, the U.S. Clean Air Act prescribes a maximum allowable increase in concentrations of SO_2 for Class I and Class II areas. These values for Class II areas are shown in Table 5.1-1. The percent of allowable increases for Class II areas used by the maximum increases in SO_2 concentrations predicted are given below:

	Percent Class II PSD Consumed	
Time Period	600 MW	1200 MW
3 hour	19(32)[a]	38(65)
24 hour	31(50)	62(100)
Annual	(8)12	(16) 24

[a] Values in parentheses are based on results of Gelhaus (1980).

It should be emphasized that the preceding comparisons are based on the maximum predicted SO_2 concentrations. The predicted concentrations for most of the study area are considerably less than the maximum values. For example, the predicted annual SO_2 concentrations for most of Daniels County and all of Roosevelt County are about an order of magnitude less than the maximum values which occur near the International Boundary. Such low concentrations (0.2 ug/m^3 for two 300 MW units, no control) are only about 1 percent of the Maximum Allowable Increase (PSD, Class II area). Moreover, it represents only about 0.4 percent of the Montana Ambient Air Quality Standards. Operation of a single 300 MW unit with no SO_2 control would result in predicted concentrations of one half of the preceding 600 MW values.

A similar comparison can be made for short-term SO_2 concentrations. The overall maximum 1-hour concentration of 96 ug/m^3/600 MW, (no control) would occur at or near the International Boundary. Most of Daniels County would experience highest 3-hour SO_2 exposures of 20 to 40 ug/m^3, while maximum concentrations in Roosevelt and Sheridan Counties would be less than 20 ug/m^3. These values are quite low when compared with the National Ambient Air Quality Standard of 1300 ug/m^3. Furthermore, the maximum concentrations in Roosevelt and Sheridan Counties ($\sim$30 ug/m^3) represent only 6 percent of the maximum allowable increase for Class II areas.

The nearest designated Class I area to the power plant is the Medicine Lake Wildlife Refuge located about 104 km (65 miles) southeast of the plant. The Fort Peck Indian Reservation may be designated a Class I area in the future. The reservation boundary is located 48 km (30 miles) directly south of the power plant at its closest point. The CRSTER model was used to determine if violations of the Class I PSD requirements could occur at either of these places. The predictive capability of the CRSTER model falls off very rapidly at distances over 48 km (30 miles) but it can be used to provide an upper limit concentration. The predictions at these distances would be very conservative due to the use of average wind speeds and directions which are not a function of distance, lack of vertical variation of dispersion coefficients, and lack of loss with distance due to chemical processes and deposition.

The model results showed that at the Medicine Lake Refuge the predicted 24-hour SO_2 concentration for four 300 MW units is between 7.1 and 9.2 ug/m^3. Both predictions exceed the maximum allowable increase for a Class I area of 5 ug/m^3. The predicted concentrations for two 300 MW units are less than the maximum allowable increase in 24 hours. The 3-hour and annual concentrations are less than the maximum allowable increases of 25 and 2 ug/m^3, respectively, for two and four 300 MW units. Predictions using 60 and 90 SO_2 control to meet all Class I requirements are discussed in Section 3.1.

Predicted SO_2 concentrations with two 300 MW units and no control at the Fort Peck Indian Reservation Boundary exceed the maximum allowable increase for a Class I area for 24 hours using the results presented here and equal the allowable increase for a 3-hour period. Gelhaus' results (1980) predict that the 3-hour allowable increase is also exceeded. These results and the reductions with 60 and 90 percent SO_2 control are also discussed in Section 3.1. For four 300 MW units, both model predictions are that the 3-hour and 24-hour limits would be exceeded.

5.1.5.2 NO_x Impact

The predicted increases in NO_x annual concentrations are 1.6 ug/m^3 for four 300 MW units and 0.8 ug/m^3 for two 300 MW units. This is well below the 100 ug/m^3 NAAQS. The predicted highest NO_x 1-hour concentrations in the impact area of 148 ug/m^3 and 268 ug/m^3 (Gelhaus, 1980) are below the Montana standard of 564 ug/m^3. There are no PSD requirements for NO_x.

5.1.5.3 Particulate Impact

The present particulate loading in the impact area has an annual geometric mean of about 20 to 25 ug/m^3. On an annual basis four 300 MW units with 99 percent control will only add about 0.4 ug/m^3 to the present background concentrations. This is only about 2 percent of the maximum allowable particulate increase permitted by the prevention of significant deterioration (PSD) regulations. The Montana and U.S. annual particulate standards of 60 and 75 ug/m^3, respectively, would, therefore, not be exceeded in the impact area.

The present 24-hour maximum particulate concentrations measured in the impact area by the Montana Air Quality Bureau range from 100 to 109 ug/m^3. The predicted maximum increase of 5.2 ug/m^3 for four 300 MW units with 99 percent control would result in maximum 24-hour concentrations of 105 to 115 ug/m^3. These values are below the Montana standard of 200 ug/m^3 and the U.S. secondary standard of 150 ug/m^3. The predicted increase is about 14 percent of the maximum allowable increase under PSD regulations for Class II areas.

The maximum predicted increased particulate concentrations at the Fort Peck Indian Reservation for four 300 MW units and 99 percent control are 1.8 ug/m^3 for a 24-hour period (Gelhaus, 1980) and 0.16 ug/m^3 for an annual period (model results presented here). Both of these increases are below the PSD requirements for Class I areas of 10 ug/m^3 for a 24-hour period and 5 ug/m^3 for an annual period. Model predictions with 99.5 percent control are presented in Section 3.1.

The trace metal analyses of collector ash from Poplar River Coal were used in conjunction with model predictions to estimate potential elevations in atmospheric trace metal concentrations. The maximum annual increase in particulate concentrations was assumed to be about 0.1 ug/m^3 (600 MW capacity with 99.5 percent emissions control). Such concentrations could be expected to occur very near the International Boundary; however, the annual particulate increases over most of the impact area would be approximately one order of magnitude less (~0.01 ug/m^3) (Figure 5.1-7).

The resultant predicted trace element concentrations are presented in Table 5.1-2. These values were then compared with background trace element concentrations measured by Mesich and Taylor (1975) at Glasgow, Montana (Table 5.1-3). The comparisons indicate that operation of two 300 MW units would result in very minimal increases in background concentrations. The predicted annual increases range from 0.02 to 2.2 percent of the background levels (Table 5.1-2). These differences would not be detectable with air quality monitoring equipment. Even if the highest 24-hour particulate concentrations were considered (1.0 ug/m^3), the resultant increases over background would be only about 2 to 20 percent. Moreover, such increases would occur only at locations near the International Boundary.

Table 5.1-2

CALCULATED INCREASES IN AIR CONCENTRATIONS OF TRACE ELEMENTS NEAR THE POPLAR RIVER PLANT

	Maximum Increase[1] in Annual Concentration ($\mu g/m^3$)	Percent Increase Above Background
Antimony	9.8×10^{-7}	0.5
Arsenic	7.4×10^{-7}	0.3
Beryllium	4.6×10^{-8}	0.3
Cadmium	2.4×10^{-8}	0.05
Chromium	6.8×10^{-6}	0.1
Copper	3.7×10^{-6}	0.2
Germanium	1.8×10^{-7}	1.4
Lead	1.6×10^{-5}	0.3
Manganese	6.0×10^{-5}	2.2
Nickel	1.1×10^{-6}	0.06
Selenium	2.9×10^{-7}	0.2
Silver	1.7×10^{-6}	0.06
Vanadium	3.2×10^{-6}	0.4
Zinc	2.5×10^{-6}	0.02

[1] Assuming atmospheric particulate concentration of 0.1 $\mu g/m^3$.

Table 5.1-3

1975 BACKGROUND TRACE ELEMENT CONCENTRATIONS ($\mu g/m^3$) MEASURED NEAR GLASGOW, MONTANA

	Composite Samples			
Element	1st Quarter	2nd Quarter	3rd Quarter	4th Quarter
Aluminum	0.5	1.0	0.6	1.0
Antimony	$<6 \times 10^{-5}$	2×10^{-4}	3×10^{-4}	3×10^{-4}
Arsenic	2×10^{-4}	2×10^{-4}	3×10^{-4}	2×10^{-4}
Beryllium	$<2 \times 10^{-5}$	$<2 \times 10^{-5}$	$<2 \times 10^{-5}$	$<6 \times 10^{-6}$
Cadmium	2×10^{-5}	3×10^{-5}	1×10^{-4}	3×10^{-5}
Chromium	2×10^{-3}	9×10^{-3}	7×10^{-3}	2×10^{-3}
Copper	3×10^{-3}	2×10^{-2}	3×10^{-2}	1×10^{-2}
Germanium	$<5 \times 10^{-6}$	1×10^{-5}	3×10^{-5}	$<6 \times 10^{-6}$
Lead	3×10^{-3}	9×10^{-3}	1×10^{-2}	3×10^{-3}
Manganese	$<4 \times 10^{-3}$	$<3 \times 10^{-3}$	$<3 \times 10^{-3}$	1×10^{-3}
Nickel	2×10^{-4}	2×10^{-3}	5×10^{-3}	$<7 \times 10^{-5}$
Selenium	2×10^{-5}	1×10^{-4}	2×10^{-4}	2×10^{-4}
Silver	1×10^{-5}	5×10^{-5}	3×10^{-5}	2×10^{-5}
Vanadium	4×10^{-4}	7×10^{-4}	2×10^{-3}	3×10^{-4}
Zinc	4×10^{-3}	1×10^{-2}	2×10^{-2}	1×10^{-2}

Source: Mesich and Taylor, 1976.

5.1.5.4 Fumigation Impact

Fumigation may cause high ground-level concentrations of pollutants in a small area for short periods (less than an hour) during the break-up of a low-level inversion. Fumigation occurs as a result of a plume from a stack emitting into a low-level stable layer (a-a' in Figure 5.1-9) during the night. Because of the stable conditions, little or none of the effluent reaches the ground level. However, after sunrise, solar heating causes the daytime mixed layer to form next to the surface and grow thicker with time. As the top of the mixed layer envelopes the plume (b-b' in Figure 5.1-9), it is diffused downward and may produce high ground-level concentration in the narrow region below the original stable plume. This occurs for short periods generally less than an hour. The frequency of inversions and the mechanisms for break-up are discussed in more detail in Appendix A-8. The CRSTER Model does not incorporate fumigation in estimating pollutant concentrations. However, Turner (1970) developed a method for estimating peak concentrations resulting from plume fumigation. Following this technique and employing the emission and stack parameters utilized in the CRSTER Model, concentrations were estimated for Pasquill stability categories E and F. The results are presented in Table 5.1-4.

For very stable conditions (CAT F) with two 300 MW units operating SO_2 concentrations of 1000 to 2000 ug/m^3 may occur 10-20 kilometers downwind. Concentrations of NO_x may range from 430 to 680 ug/m^3, while particulate concentrations of 55 to 85 ug/m^3 may occur. These concentrations are those that might occur when wind speeds are light and a very strong surface inversion is present.

Fumigation concentrations under more typical meteorological conditions for Scobey, Montana are presented for the midseasonal months in Tables 5.1-5 through 5.1-7. A summary of the meteorological conditions for these months and the height of the plume above the surface are presented in Table 5.1-8. The meteorological conditions are based on upper-air temperature soundings and wind rose tables for Scobey, Montana. These data were presented and discussed by Gelhaus, et al. (1979). The plume heights were calculated using the Briggs' (1969, 1970, 1972) plume rise equations. Both the plume heights and the inversion intensities ($\Delta T/\Delta Z$) showed little seasonal variation. The plume heights were close to 200 meters, while the inversions were of moderate to strong intensity.

The concentrations shown in Tables 5.1-5 through 5.1-7 are only one-half to one-third the values resulting from the more severe meteorological conditions (Table 5.1-4). The highest concentrations occur in the winter with a minimum in the autumn. Also, concentrations decrease as the plume width increases with downwind distance. At 10 kilometers (km) downwind from the source, the concentrations at a distance of 500 meters from the plume centerline are only 25 percent of those found at the centerline. At 20 km, the concentrations drop to 16 percent of centerline concentrations at a distance of 1000 meters from the centerline. Wintertime SO_2 fumigation concentrations, along the plume centerline, range from 912 ug/m^3 at 10 km to 241 ug/m^3 at 40 km for two 300 MW units. In the autumn, when the SO_2 concentrations may be the lowest, the values range from about 570 ug/m^3 at 10 km to 150 ug/m^3 at 40 km.

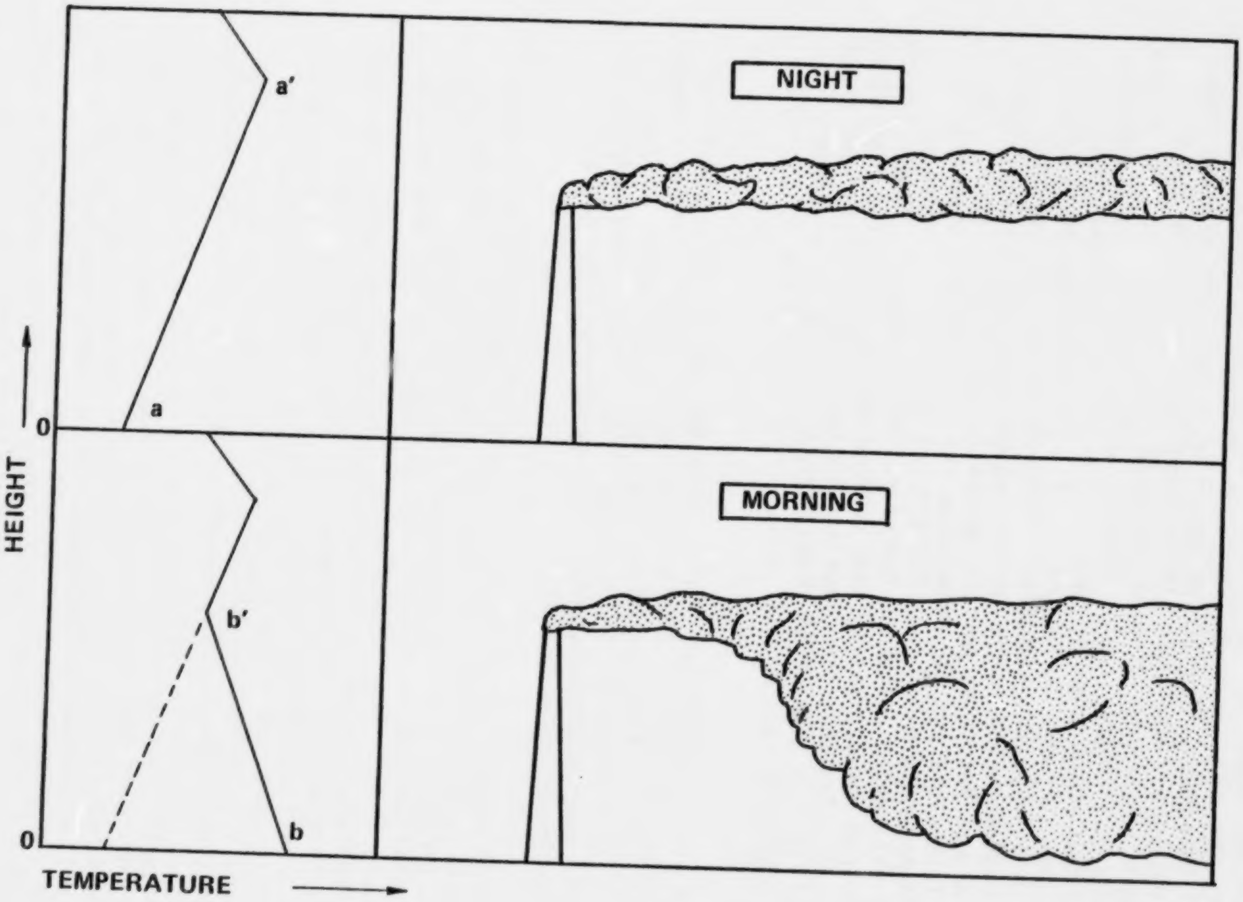

NIGHT
MORNING
a'
a
b'
b
0
0
HEIGHT
TEMPERATURE

Figure 5.1-9. SCHEMATIC OF LOW-LEVEL INVERSION BREAKUP RESULTING IN FUMIGATION

Table 5.1-4

ESTIMATES OF MAXIMUM GROUND-LEVEL CONCENTRATIONS ($\mu G/M^3$) DURING MORNING FUMIGATION

Downwind	Stab Cat E (Wind Speed 5 m/s)						Stab Cat F (Wind Speed 3 m/s)					
Distance (Km)	600 MW			1200 MW			600 MW			1200 MW		
	SO_2	NO_x	TSP	SO_2	NO_x	TSP	SO_2	NO_x	TSP	SO_2	NO_x	TSP
10	804	270	34	1608	540	68	2016	676	85	4032	1352	170
15	634	213	27	1268	426	54	1571	527	66	3142	1054	132
20	508	171	21	1016	342	42	1301	436	55	2602	872	110

Table 5.1-5

ESTIMATES OF MAXIMUM GROUND-LEVEL SO_2 CONCENTRATIONS ($\mu G/M^3$) DURING MORNING FUMIGATION RESULTING FROM TYPICAL METEOROLOGICAL CONDITIONS AT SCOBEY, MONTANA

DOWNWIND DIST. (km)	600 MW				1200 MW			
	JAN	APR	JUL	OCT	JAN	APR	JUL	OCT
Along Plume Centerline (CL)								
10	912	863	822	568	1824	1726	1644	1136
20	484	457	434	301	968	914	868	602
30	321	303	288	195	642	606	576	390
40	241	227	216	149	482	454	432	298
500 m From CL								
10	232	218	207	143	464	436	414	286
20	308	291	276	191	616	582	552	382
30	258	244	232	160	516	488	464	320
40	211	199	189	131	422	398	378	262
1000 m From CL								
10	3.8	3.5	3.3	2.3	7.6	7.0	6.6	4.6
20	79.9	75.1	71.3	49.5	160	150	143	99.0
30	134	126	120	83.3	268	252	240	167
40	143	134	128	88.4	286	268	256	177

Note: Estimates are based on meteorological conditions shown in Table 5.1-8 with zero SO_2 control.

Table 5.1-6

ESTIMATES OF MAXIMUM GROUND-LEVEL NO_x CONCENTRATIONS ($\mu G/M^3$ DURING MORNING FUMIGATION RESULTING FROM TYPICAL METEOROLOGICAL CONDITIONS AT SCOBEY, MONTANA

DOWNWIND DIST. (km)	600 MW				1200 MW			
	JAN	APR	JUL	OCT	JAN	APR	JUL	OCT
Along Plume Centerline (CL)								
10	306	290	276	191	612	580	552	382
20	162	153	146	101	324	306	292	202
30	108	102	96.6	65.4	216	204	193	131
40	80.8	76.2	72.5	50.0	162	152	145	100
500 m From CL								
10	77.8	73.1	69.4	48.0	156	146	139	96.0
20	103	97.6	92.6	64.1	206	195	185	128.2
30	86.6	81.9	77.8	53.7	173	164	156	107
40	70.8	66.8	63.4	43.9	142	134	127	87.8
1000 m From CL								
10	1.3	1.2	1.1	0.8	2.6	2.4	2.2	1.6
20	26.8	25.2	23.9	16.6	53.6	50.4	47.8	33.2
30	45.0	42.3	40.3	27.9	90.0	84.5	80.6	55.8
40	48.0	45.0	42.9	29.7	96.0	90.0	85.8	59.4

Note: Estimates are based on meterological conditions shown in Table 5.1-8.

Table 5.1-7

ESTIMATES OF MAXIMUM GROUND-LEVEL TOTAL SUSPENDED PARTICULATE (TSP) CONCENTRATIONS ($\mu G/M^3$) DURING MORNING FUMIGATION RESULTING FROM TYPICAL METEOROLOGICAL CONDITIONS AT SCOBEY, MONTANA

DOWNWIND DIST. (km)	600 MW				1200 MW			
	JAN	APR	JUL	OCT	JAN	APR	JUL	OCT
Along Plume Centerline (CL)								
10	38.2	36.2	34.5	23.8	76.4	72.4	69.0	47.6
20	20.3	19.2	18.2	12.6	40.6	38.4	36.4	25.2
30	13.5	12.7	12.1	8.2	27.0	25.4	24.2	16.4
40	10.1	9.5	9.1	6.3	20.2	19.0	18.2	12.6
500 m From CL								
10	9.7	9.1	8.7	5.2	19.4	18.2	17.4	10.4
20	12.9	12.2	11.6	8.0	25.8	24.4	23.2	16.0
30	10.8	10.2	9.7	6.7	21.6	20.4	19.4	13.4
40	8.9	8.3	7.9	5.5	17.8	16.6	15.8	11.0
1000 m From CL								
10	0.2	0.2	0.1	0.1	0.4	0.4	0.2	0.2
20	3.4	3.2	3.0	2.1	6.8	6.4	6.0	4.2
30	5.6	5.3	5.0	3.5	11.2	10.6	10.0	7.0
40	6.0	5.6	5.4	3.7	12.0	11.2	10.8	7.4

Note: Estimates are based on meterological conditions shown in Table 5.1-8 with 99.5 percent control.

Table 5.1-8

AVERAGE METEOROLOGICAL CONDITIONS (100-200 M LAYER) AND PLUME HEIGHTS DURING THE MORNING FOR THE MID-SEASONAL MONTHS AT SCOBEY, MONTANA

PARAMETERS	MONTH JAN	 APR	 JUL	 OCT
T (°C)	-17	2	12	2
$^{\Delta T}/_{\Delta Z}$ (°C/m)	0.013	0.017	0.018	0.016
Pasquill Stability Category	F	F	F	F
Wind Speed (m/s)	6.3	6.8	7.2	10.3
Plume Height (m)	216	210	208	211

distance of 6 km by Gelhaus (1980) using Turner's method. The maximum predicted concentrations (which occur in January) for two 300 MW units, no SO_2 control, is 7,580 ug/m^3. This is much higher than the estimate for 6 km using typical meteorological data for January which gives an SO_2 concentration of 1,465 ug/m^3 and using stability category F conditions which gives an estimated SO_2 concentration of 5,400 ug/m^3. The higher estimate of Gelhaus could not be duplicated.

The NO_x wintertime concentrations along the plume centerline may range from 306 ug/m^3 at 10 km to 81 ug/m^3 at 40 km for two 300 MW units (Table 5.1-6), while particulate concentrations with 99.5 percent control may range from 38 ug/m^3 to 10 ug/m^3 at 10 and 40 km, respectively (Table 5.1-7).

The frequency of plume fumigation will most likely be the greatest in the spring and summer and the lowest in the autumn and winter. Statistics on the frequency of stability categories during the hours from 0000 to 0600 MST, presented by Gelhaus, et al. (1979) for Scobey, Montana, show that the F stability category (moderately stable) occurs about 25 to 30 percent of the time in autumn and winter and 35 to 45 percent in the spring and summer. Thus, the probability of local plume fumigations with concentrations of the magnitude shown in Tables 5.1-5 through 5.1-7 is relatively high.

Fumigation events will result in high concentrations of SO_2 within the impact area but they will be of short duration and confined to relatively small areas. While there are currently no national air quality standards (primary or secondary) for periods less than or equal to 1-hour, the potential exists for exceeding Montana's 1-hour standard, which states that SO_2 concentrations shall not exceed 655 ug/m^3 for more than 1-hour in any four consecutive days. As indicated in Table 5.1-5, concentrations in excess of the state's standard may occur in that area between 10 and 20 km from the emission source for two 300 MW units and in that area less than 30 km from four 300 MW units during fumigation events. Based on the estimates for fumigation presented here, violations of the 1-hour standard for SO_2 could occur with four 300 MW units but not with two units. Using the estimates at a 6 km distance given in Gelhaus (1980) violations could occur for two units. However, due to variable wind conditions and the fact that predicted SO_2 concentrations at a distance of 500 m from the plume centerline are less than the state standards at all distances greater than or equal to 10 km from the emission source, it is improbable that excess SO_2 concentrations will occur for more than 1-hour during the specified time interval. Also, the area most likely to be subject to fumigation is at distances of 10 to 20 km between the 110 degree and 250 degree azimuths.

Montana's 1-hour NO_x standard of 564 ug/m^3 could be exceeded under stability category F conditions with two 300 MW units if fumigation lasted 45 minutes. Since there is no short-term ($\leq$ hour) state or national standards for particulates, there is no reasonable basis for comparison with predicted values. Potential effects of these constituents and SO_2 will be discussed, however, in the vegetation impacts section (5.6.1).

5.1.5.5 Visibility Impacts

Mathematical models describing the visual effects of power plant emission plumes are in the early stages of development. Recently, for example, a model has been developed to estimate the spatial and temporal distribution as well as the magnitude of visibility impairment resulting from power plant emissions of SO_2 and NO_x at various control levels (Latimer, 1980). Although the results of a generic application of this model for power plants in the west have been published, the generating capacity, meteorological and operating assumptions for the model plant were such that a comparison with the SPC power plant was not appropriate. Therefore, in the absence of suitable results, a quantitative estimate of visibility impairment in Montana resulting from emissions of the SPC power plant will not be provided.

In general, visibility impairment resulting from a coal-fired power plant may be classified into two types - short-range (<100 km) and long-range (>100 km). The short-range type, known as plume blight, occurs when a plume is perceptible because of its coloration. The long-range type, where the plume itself is not visible, results in regional haziness, and the visual range is reduced by plume aerosol. The short-range type generally results from NO_x emissions. Nitrogen dioxide (NO_2) formed in the atmosphere from nitric oxide (NO) emissions is visible as a yellow or brown haze, particularly on mornings with stable, light-wind meteorological conditions. The long-range type results from SO_2 emissions, which are slowly converted in the atmosphere into sulfate aerosol, which reduces visual range by contributing to regional haze.

5.1.5.6 Health Effects

Epidemiological investigations have shown relationships between increased mortality and disease in populations exposed to elevated levels of atmospheric pollutants (National Academy of Sciences, 1975). The compounds primarily associated with health effects are sulfur oxide-particulate complexes. These are formed by the combination of SO_2 gas and its conversion products (sulfuric acid and sulfate aerosols) with suspended particulate matter.

The values presented in Table 5.1-9 provide an indication of the concentrations of atmospheric pollutants associated with health effects. Based on the projected levels of SO_2, NO_x and TSP associated with the operation of the Poplar River power plant, it is concluded that there will be no adverse health effects in populations residing within the Poplar River Basin.

Table 5.1-9

EXPECTED HEALTH EFFECTS OF AIR POLLUTION ON SELECTED POPULATION GROUPS

	Value ($\mu g/m^3$) Causing Effect			
Pollutant	Excess Mortality and Hospital Admissions	Worsening of Patients with Pulmonary Disease	Respiratory Symptoms	Visibility and/or Human Annoyance Effects
SO_2[a]	500 (daily average)	500–250[b] (daily average)	100 (annual arithmetic mean)	80 (annual geometric mean)
Smoke[a]	500 (daily average)	250 (daily average)	100 (annual arithmetic mean)	80 (annual geometric mean)[c]

[a] British Standard Practice (Ministry of Technology, 1966). Values for sulfur dioxides and suspended particulates apply only in conjunction with each other. They may have to be adjusted when translated into terms of results obtained by other procedures.

[b] These values represent the differences of opinion within the committee of experts.

[c] Based on high-volume samplers.

Source: Shy, 1978

5.2 WATER QUANTITY IMPACTS

5.2.1 Methodology

5.2.1.1 Flow Scenarios

Flow impacts were assessed using predicted monthly flows for 1933-1974 from the Karp II model of the Poplar River and the Modified Montreal Engineering (MME) model of Cookson Reservoir. Results are given at 12 stations (Figure 5.2-1). The Karp II Model was run for natural, historical, and existing conditions, six apportionment proposals, unlimited Canadian uses, and two cases with ash lagoon discharge entering Cookson Reservoir. This section will discuss the impacts of Apportionment VI. The other apportionments are discussed as alternatives in Chapter 3.

The natural flows were estimated using available flow data and interstation correlations to complete the flow record (Poplar River Task Force, 1976b). Historical flows were also estimated from available flow data and interstation correlations (Poplar River Task Force, 1976b). The existing flows were developed for 1975 levels of development with the Cookson Reservoir but with no power plant in operation. The unlimited Canadian water uses scenario allows all Canadian water to be used to represent a "worst case."

Apportionment VI splits the total natural flow of the Poplar River and tributaries at the International Border evenly between Canada and the U.S. In addition to this principal requirement the flow of the West Fork (stations 9 and 10) must be at least 50 percent of the natural flow and the flow of the Middle Fork (station 4) must be at least 60 percent of the natural flow. Flow in Cow and Coal Creeks (station 2 and 5) must also be at least 40 percent of the natural flow. Flow in the East Fork depends on the flow at station 4 because different size releases are made as shown in Table 5.2-1. If flows are needed to meet the apportionment, the flow releases were made by the model from stations 2 and 5 first and station 4 second to simulate apportionment. In reality, there are no facilities at these locations to make such releases.

5.2.1.2 Model Description

Flow scenarios with the proposed apportionment were run for five levels of development. The various scenarios used in analysis of impacts are summarized in Table 5.2-2. The scenarios 28 through 32 simulations included power plant evaporation but did not include discharge from the ash lagoons as an inflow to Cookson Reservoir. Scenarios 4A and 8A were simulated using the MME model to provide a "worst-case" where all the ash lagoon discharge reaches Cookson Reservoir. Since the modeling work was done SPC has lined the lagoons with clay and will recirculate the water instead of discharging it to Cookson Reservoir. The effect

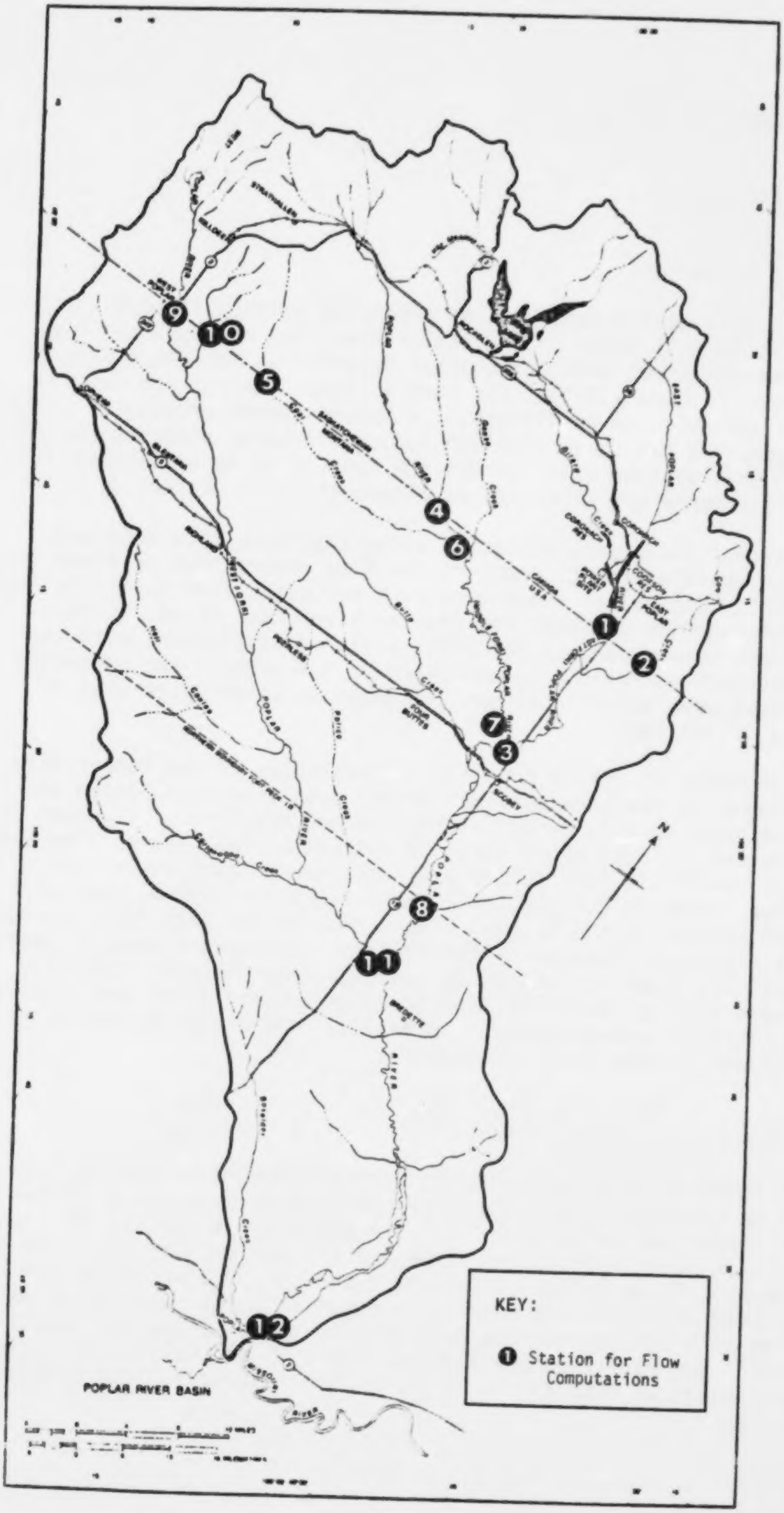

1
2
3
4
5
6
7
8
9
10
11
12
POPLAR
Creek
FOUR BUTTES
CANADA
USA
N
POPLAR RIVER BASIN
KEY:
❶ Station for Flow Computations

Figure 5.2-1 LOCATION OF STATIONS WITH FLOW RESULTS

Table 5.2-1

RESERVOIR RELEASES ON THE EAST FORK OF THE POPLAR RIVER

Flow at Station 4[+]	Continuous Release		Scheduled Release	
Acre-Feet	Acre-Feet	Months	Acre-Feet	Months[++]
0-3,800	60	All year	300	May-September
3,801-7,500	60	September-May	500	May-September
	120	June-August		
7,501-12,000	120	September-May	500	May-September
	180	June-August		
>12,000	120	September-May	1,000	May-September
	180	June-August		

[+] Sum of March through May flows at Middle Fork below the confluence with Goose Creek.

[++] Schedule for releases is based on irrigation need as follows:

Month	May	June	July	August	September
Percent	12	18	32	27	11

Amount of releases from scenario descriptions of Montana Health and Environmental Sciences.

Table 5.2-2

SUMMARY OF FLOW SCENARIOS

Scenario No.	Flow Type	Level of Development	No. of 300 MW Units
1	Natural	Predevelopment	0
2	Historical	Historical 1933-1974	0
3	Existing	1975 & Cookson Res.	0
28	App. VI*	1975	1
29	App. VI	1985	2
30	App. VI	1985	3
31	App. VI	2000	3
32	App. VI	2000	4
4A	App. VI+	1975	1
8A	App. VI+	1985	2

*Apportionment VI of Poplar River Task Force (1979).

+These scenarios include discharge from the ash lagoon entering Cookson Reservoir.

of the ash lagoons is discussed in more detail in Section 5.3 Water Quality Impacts. A brief summary of the Karp II and MME models will be given here with a detailed discussion included in Appendix D. The Karp II model uses the estimated monthly natural flows and the estimated monthly flow at the East Fork border station from the reservoir model as input for the years 1933 to 1974. The net water uses discussed in the following section are subtracted from these flows corresponding to the appropriate scenario. Table E-2 in the Appendix gives the detailed uses and amounts of the surface and subsurface return flows. The output of the model is monthly flows for 1933 to 1974 for each of the 13 stations (see Figure 5.2-1). A cumulative frequency distribution was computed and the flows exceeded 10, 50, and 90 percent of the time were listed in a summary section along with the mean flows.

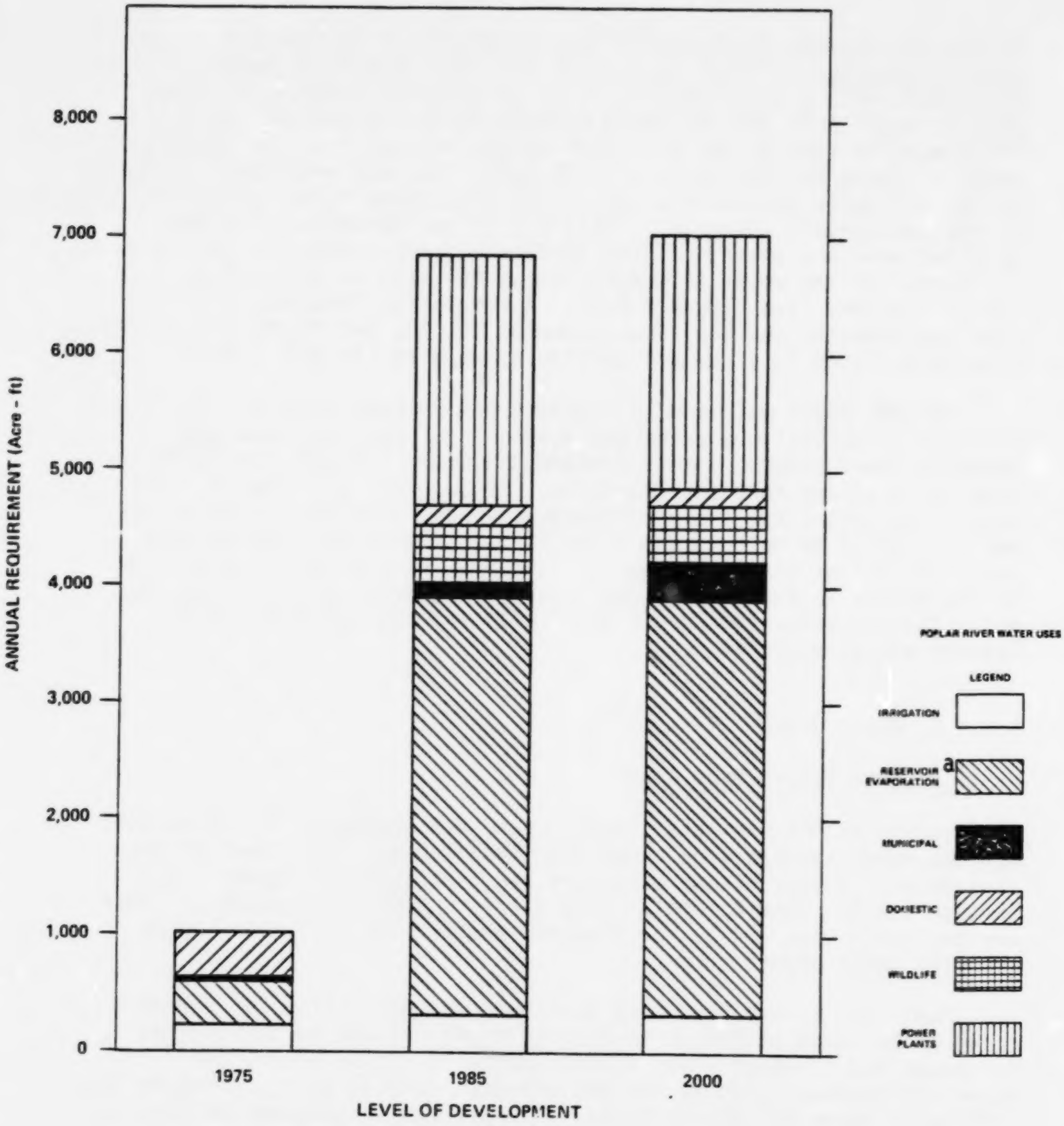
The MME model was used to simulate the Cookson Reservoir as affected by natural processes and operation of the coal mine and Canadian power plant. Inputs include tributary inflows, precipitation, natural and forced evaporation, inflows from ash lagoons, mine dewatering, releases, and groundwater seepage. The Cookson Reservoir was assumed to be full at the start of the simulation. The maximum reservoir volume was 32,550 ac-ft. The flow on the East Fork station at the border is determined from reservoir releases specified in the apportionment scenarios (see Table 5.2-1) and seepage from the ash lagoons and groundwater.

5.2.1.3 Water Uses

Canadian Future Uses (1985)

Except in the indicated cases, water use estimates of future uses for the model studies were taken from Saskatchewan Department of the Environment (1978). These estimates are portrayed in Figures 5.2-2 through 5.2-4. (See Appendix Table E-4 for supporting values.) These are projected uses and do not consider whether the full uses can be supplied under apportionment.

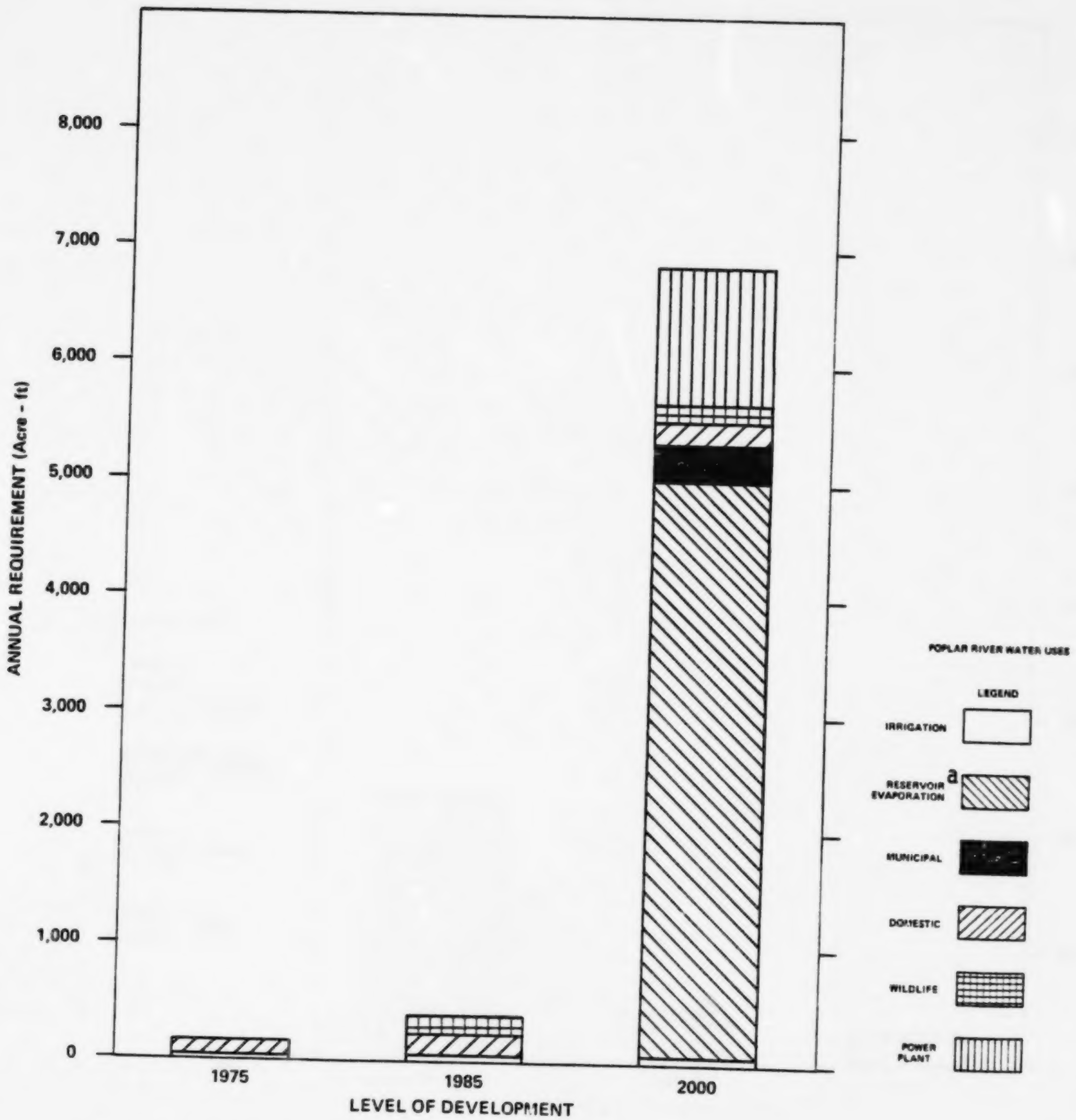
Municipal future uses were developed for the Village of Coronach based on inflated estimates of population levels due to anticipated increases due to development of coal deposits in the area. The expected increase cited by the above report was 114 ac-ft, bringing the 1985 total usage to 150 ac-ft/year. If per capita consumption remains constant, this represents a population increase to 1250 persons in contrast to the 1975 population estimate of 300. At the year 2000 level, assuming constant per capita consumption, 5300 persons would be the projected population. The Town of Rockglen derives its present water supply from groundwater and it was assumed that future increases could be met by that resource.



[a] Includes natural and forced evaporation.

NOTE: Uses shown do not make allowance for any limitations due to apportionment

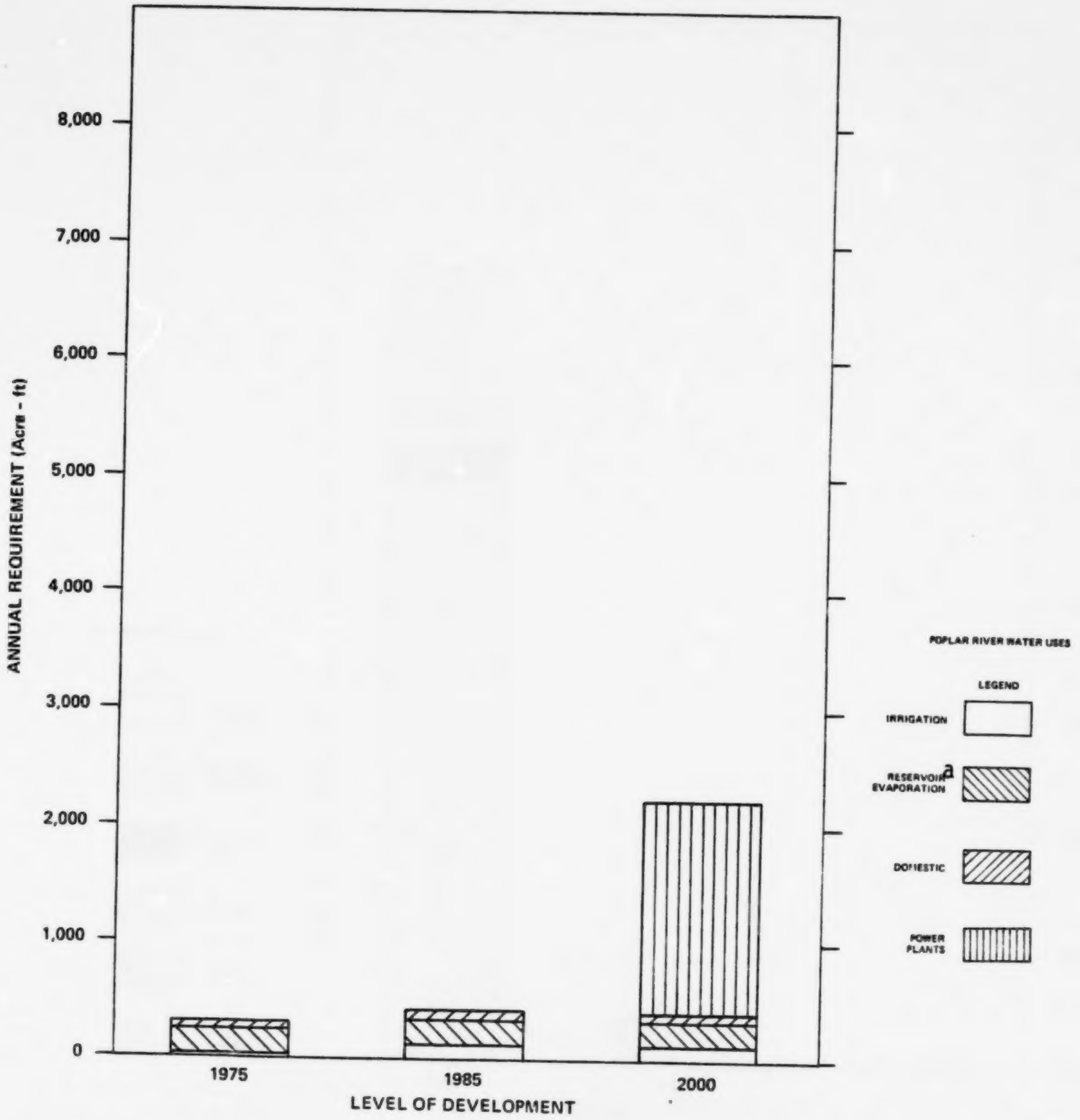
Figure 5.2-2 PROJECTED CANADIAN WATER USES ON THE EAST FORK



[a] Includes natural and forced evaporation

NOTE: Uses shown do not make allowance for any limitations due to apportionment.

Figure 5.2-3 PROJECTED CANADIAN WATER USES ON THE MIDDLE FORK



[a]Includes natural and forced evaporation

NOTE: Uses shown do not make allowance for any limitations due to apportionment.

Figure 5.2-4 PROJECTED CANADIAN WATER USES ON THE WEST FORK AND TRIBUTARIES

Future industrial uses are also predicted primarily on the development of coal resources in the area. Water requirements in 1985 would include 3,600 ac-ft for natural evaporation due to installation of a reservoir for coal-fired power plants. Installation of two new 300 MW units would require an additional 2180 ac-ft for forced evaporation and plant consumptive uses. These figures are taken from Volume One of the Poplar River Final Environmental Assessment for Saskatchewan Power Corporation (Saskmont Engineering, 1978). Forced evaporation was calculated on the basis of a 5.2°C temperature excess above normal lake water temperature for two 300 MW units. Using this excess and other meteorological data daily evaporation was calculated as follows:

$$E = b(T_s - T_d)\ f\ (U)$$

where E is the daily evaporation (Btu Ft^{-2} Day^{-1})

$b = .255 - .0085\ T + .00024\ T^2$

and $T = (T_s + T_d) / 2$

T_s = water surface temperature

T_d = dew point temperature

$f(U)$ is a windspeed function equal to $70 + 0.7\ U^2$

where U is the wind speed in miles per hour.

Losses due to an increase in thermal loading were computed as

$$dE = \frac{b(K - 15.7)}{(0.26 + b)}\ \frac{HP}{K}$$

where dE is the increase in evaporation (Btu Ft^{-2} Day^{-1})

HP is the thermal loading and

K is the coefficient of surface heat exchange equal to

$15.7 + (0.26 + b)\ f(U)$

and b and f(U) are as previously defined. The volume of water evaporated was then evaluated by making use of the latent heat of evaporation of water (about 1032 Btu/lb).

Wildlife uses were estimated at 300 ac-ft/year and divided equally between the East and Middle Forks. These uses were estimated in 1985 by Ducks Unlimited to be 1,220 ac-ft. The 300 ac-ft figure was derived as a result of considering that only 25 percent of the projects would be implemented.

Domestic uses were estimated based on linear extrapolations of historical domestic water usage increases. The Task Force predicted a 1985 use of 730 ac-ft. There is a discrepancy between this and Table E-4 in that the total domestic 1985 use is only 708 ac-ft. The difference is the usage in other small tributaries crossing the International Boundary. The uses were proportioned among the three forks based on the same percent as the 1975 percent of the total.

The Poplar River Task Force report indicated irrigation water usage by private developers to be 380 ac-ft by 1985. Altogether, based on linear extrapolation of historical growth rates, the increase was expected to be 120 ac-ft over the 1975 level of 300 ac-ft. The 120 ac-ft was proportioned among the three forks in the same way that domestic uses were. In addition, an irrigation project amounting to 100 ac-ft was planned for the West Poplar, bringing the 1985 total irrigation usage to 520 ac-ft.

Canadian Future Uses (2000)

All irrigation development presumed to occur was expected to have taken place by 1985. No further development was estimated for the year 2000.

The construction of a reservoir for power plant development accounts for the additional 4960 ac-ft of reservoir evaporation loss from the Middle Fork. This was computed similarly to the reservoir evaporation losses under the 1985 level of usage. The 1181 ac-ft of forced evaporation and plant consumptive use was also predicted as per the 1985 levels. From a water balance, 1827 ac-ft of water diverted from the West Fork was deemed necessary to allow for power plant development on the Middle Fork.

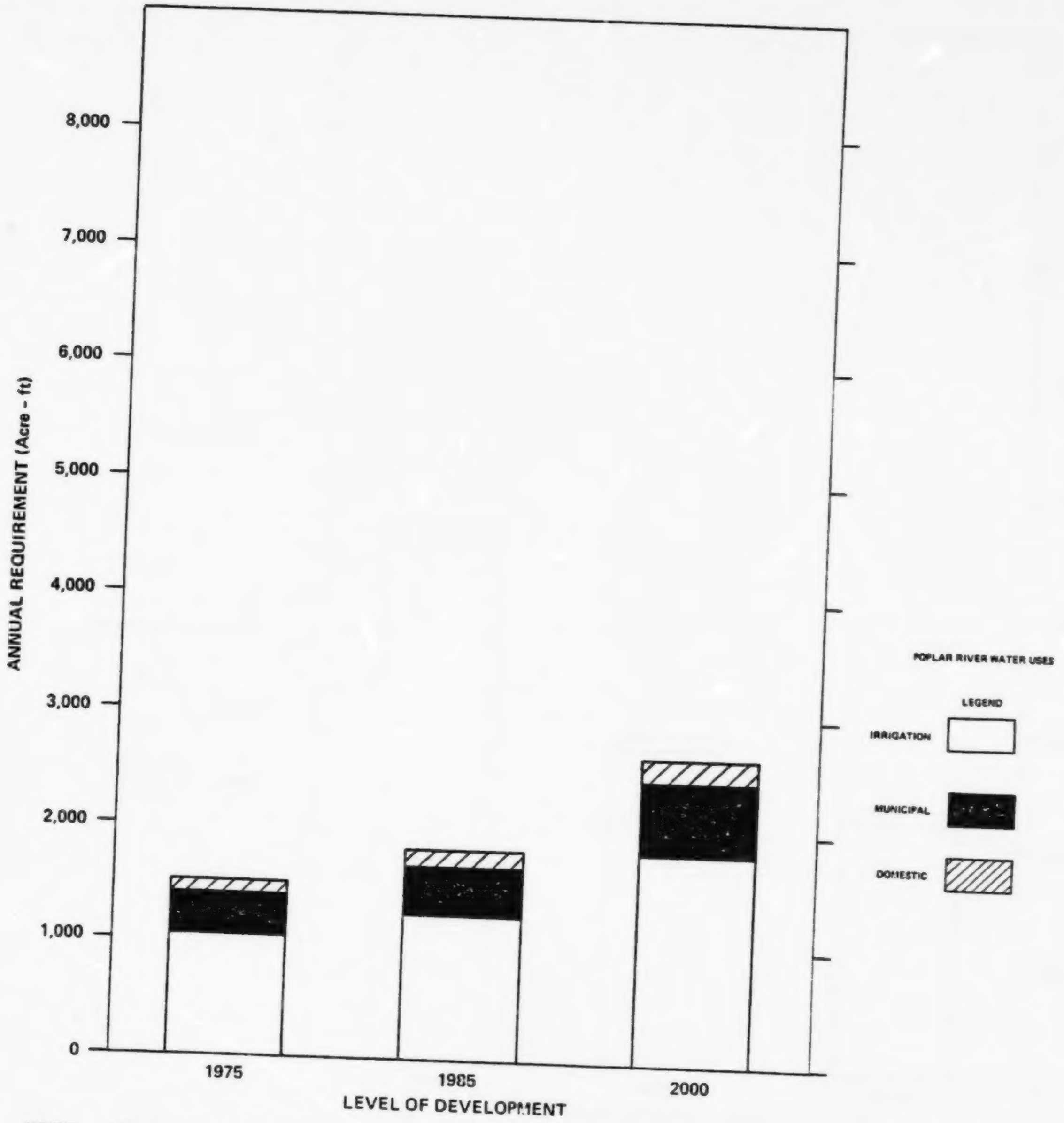
Municipal water uses for the Village of Coronach were estimated as 500 ac-ft over the 1985 level of consumption for a total of 650 ac-ft. To meet this demand an additional source of water is required and it was assumed that 333 ac-ft would be diverted from the Middle Fork to the East Fork for this purpose.

Domestic (stock-watering) and wildlife demands were not expected to increase past the 1985 levels.

United States Future Uses

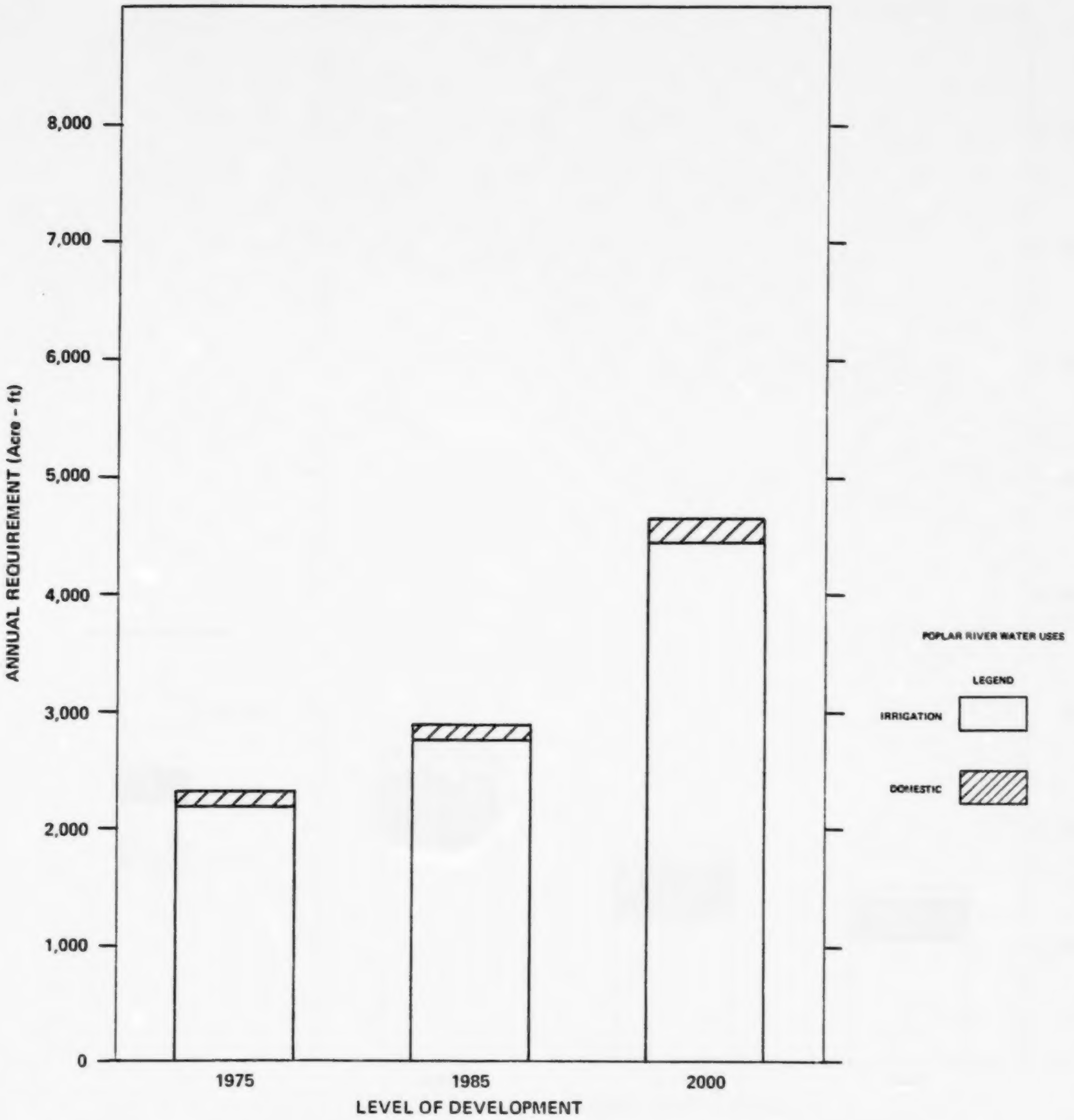
The estimates of future uses in the U.S. portion of the basin are shown in Figures 5.2-5 through 5.2-9 (see Appendix Table E-5).

The municipal demands that were used in modeling studies were assumed to be exclusively by the Town of Scobey, Montana. Projections for the future population estimates based on historic trends were made by the Montana Department of National Resources and Conservation.



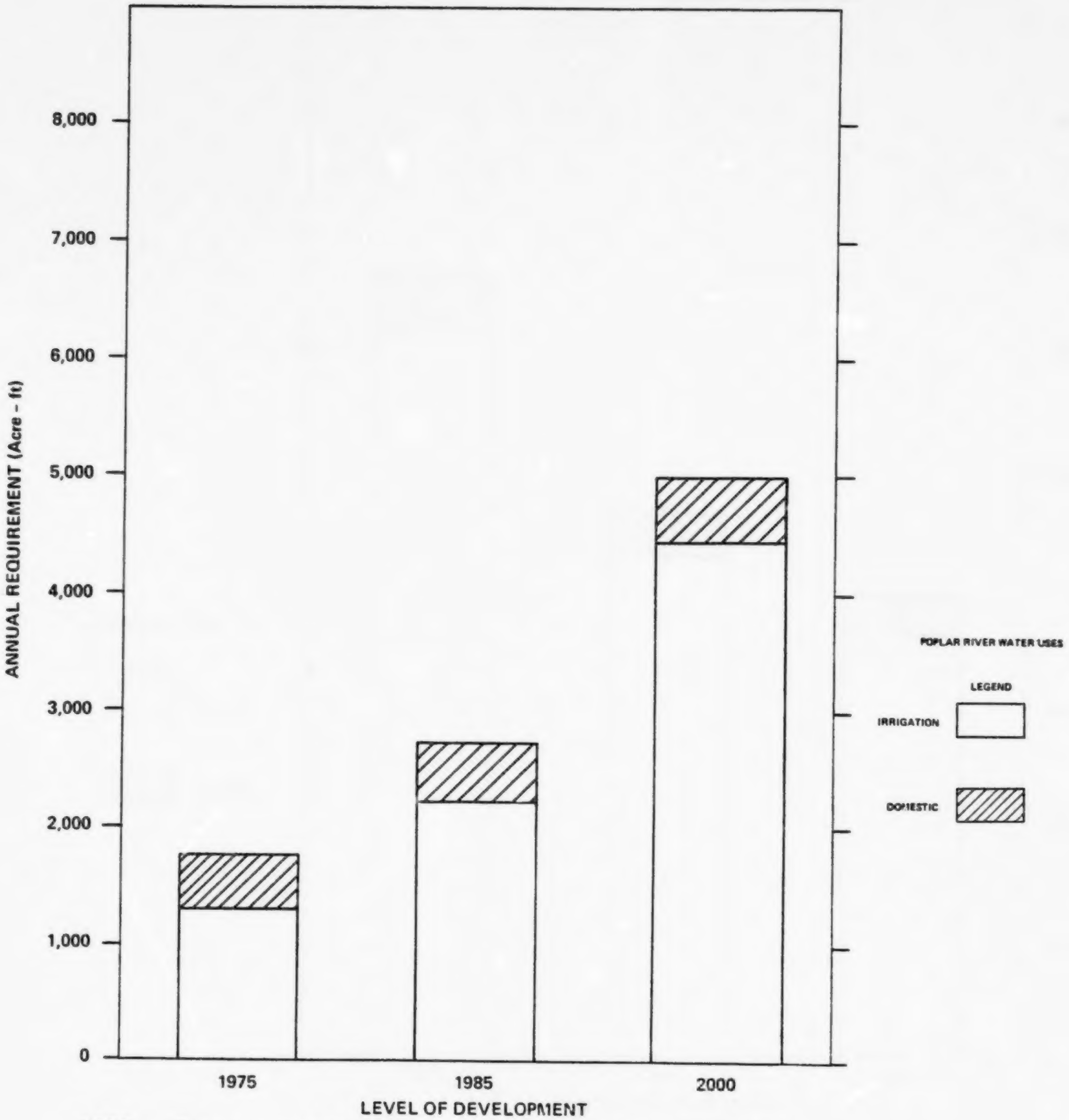
NOTE: These projected uses do not make allowance for any limitations due to apportionment.

Figure 5.2-5 PROJECTED U.S. WATER USES ON THE EAST FORK OF THE POPLAR RIVER



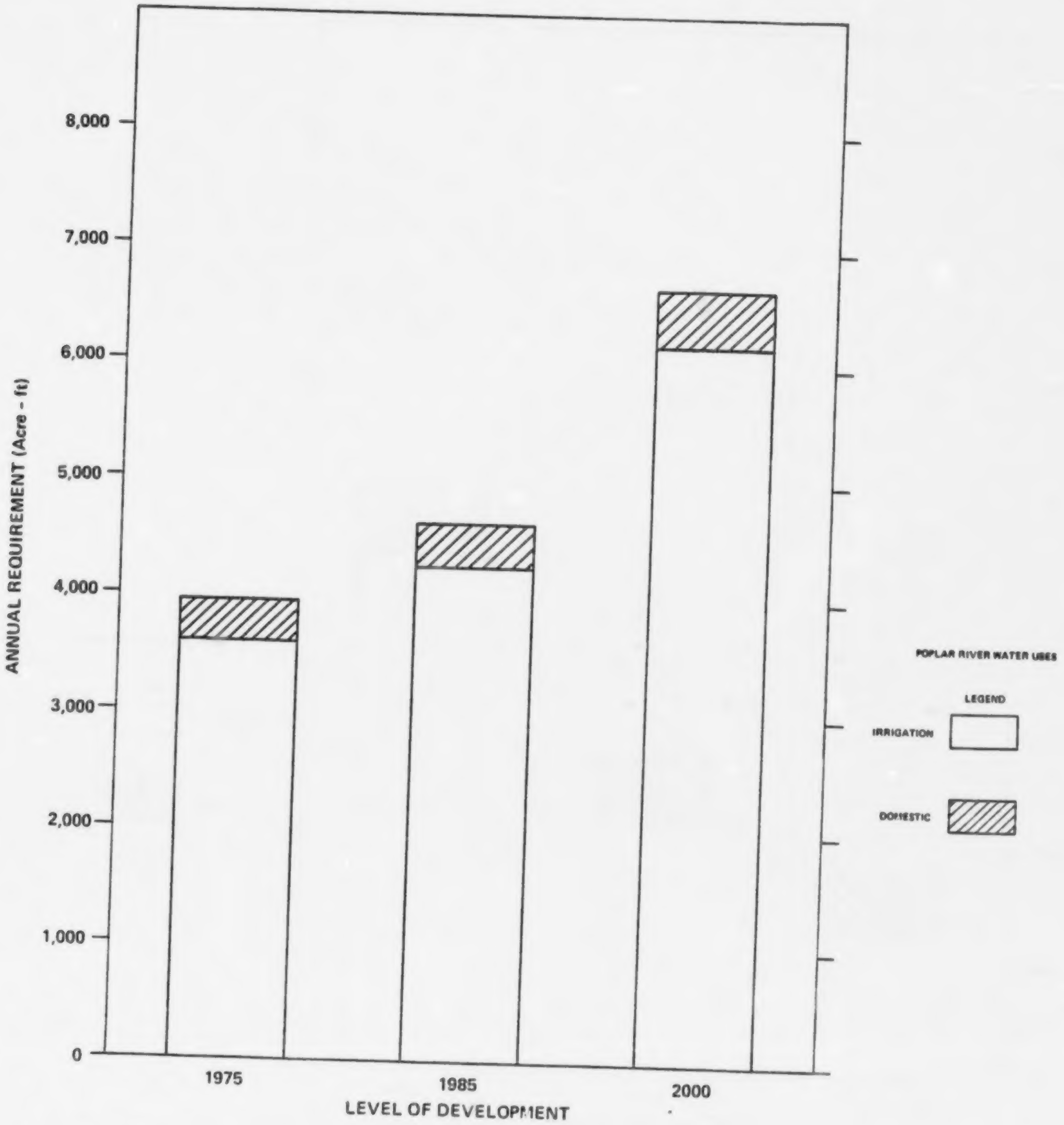
NOTE: These projected uses do not make allowances for any limitations due to apportionment.

Figure 5.2-6 PROJECTED U.S. WATER USES ON THE MIDDLE FORK OF THE POPLAR RIVER ABOVE THE CONFLUENCE WITH EAST FORK



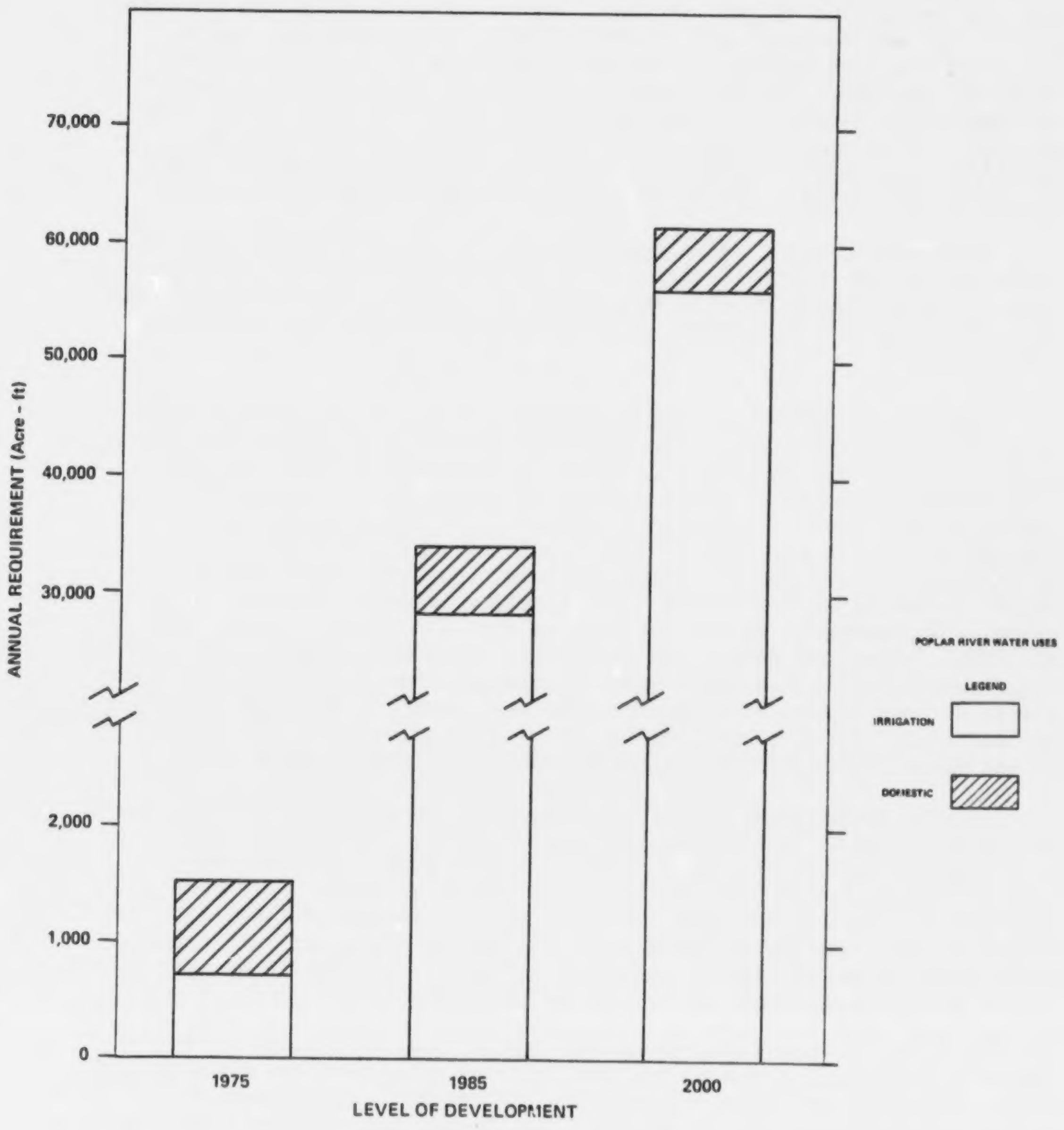
NOTE: These projected uses do not make allowance for any limitations due to apportionment

Figure 5.2-7 PROJECTED U.S. WATER USES ON WEST FORK OF THE POPLAR RIVER (INCLUDES INDIAN AND NON-INDIAN USES)



Note: West Fork uses are excluded.
These projected uses do not make allowance for any limitations due to apportionment.

Figure 5.2-8 PROJECTED U.S. WATER USES ON MAIN STEM OF POPLAR RIVER ABOVE FORT PECK INDIAN RESERVATION AND BELOW CONFLUENCE OF MIDDLE AND EAST FORKS



NOTE: These projected uses do not make allowance for any limitations due to apportionment.

Figure 5.2-9 PROJECTED U.S. WATER USES ON MAIN STEM OF POPLAR RIVER WITHIN FORT PECK INDIAN RESERVATION

In the past 15 years the population of Scobey has decreased steadily. The 1985 projection is 1445 persons. Water use per capita has increased but was assumed to level off at 250 gal/day. Using this per capita usage and the 1985 population estimate the value of 400 ac-ft in the table was derived. The development of a potash facility was expected to reverse the population trend by the year 2000 and bring it to 2160 persons. Using the same per capita usage the 600 ac-ft figure was obtained. The model diverted the water for Scobey from station 3 but the wells are located just below the confluence with the Middle Fork.

Stock and domestic water requirements for the non-Indian lands were estimated by the Montana Department of Natural Resources and Conservation for 1985 and 2000. They were based on linear extrapolation of the 1931-1975 trends. The numbers include stock uses and stock pond evaporation.

The Montana DNRC also made projections of the number of irrigated acres for each of the West, East and Middle Forks (non-Indian portions) based on linear extrapolations of 1960 through 1975 data for spreader dike irrigation systems. (The acreage estimates for all types of irrigation systems appear in Appendix Table E-3.) These systems were assumed to require a single 10 inch (.833 ft) application per year. Multiplying the projected acreages by this figure the requirements for these sub-basins were obtained. The spreader acreages for the Indian lands were assumed to remain the same as the 1975 levels through 1985 and 2000. Using the same 0.833 irrigation depth requirement, the total requirements for Indian lands were calculated. For the West Fork, the Indian and non-Indian land requirements were summed. This sum appears in Table E-5. For the Lower Poplar the indicated value is the product of estimated Indian spreader acreage and the irrigation depth alone.

Acreage projections for flood irrigation and sprinkler irrigation were also estimated with regression techniques by the Montana DNRC. Data from the period of 1961 through 1975 were used. Morrison-Maierle, Inc. (1978) estimated that the flood irrigation acreages would remain constant for the Indian lands through 2000. Estimates of seasonal diversion requirements by the Montana Health and Environmental Sciences Department, Water Quality Bureau, were 39 inches/acre for flood irrigation and 29 inches/acre for sprinkler irrigation.

Sprinkler irrigation acreages on Indian lands were expected to increase dramatically due to the availability of water from the proposed construction of two large reservoirs. The seasonal requirement for sprinkler irrigation operations was based on the requirements for alfalfa grown on class II lands. This requirement is roughly 18.5 inches/acre. Assuming a 65 percent field and conveyance efficiency about 29 inches/acre need to be diverted. Multiplying this by the total acreage in sprinkler irrigation for each sub-basin and converting inches to feet gives the volumes shown in Table E-5. Although the Morrison-Maierle report (1978) indicates the need for a much larger consumptive use per acre and hence a larger diversion volume, similar depth requirements were used for the entire basin (see next section). Water applications were made between May and September according to percentages given in Appendix Table E-1.

Domestic and stock water demands for Indian lands also include both livestock uses and evaporation from stock ponds. The substantial increase in the 1985 and 2000 figures over the 802 ac-ft of 1975 is due to the inclusion of evaporation from the two proposed reservoirs. Their combined storage would be 152,400 ac-ft and their combined surface area would be about 7700 acres. The annual evaporation from these large reservoirs is estimated as 4924 ac-ft. Including the 802 ac-ft from existing stock consumption and evaporation, the total domestic and livestock requirement tallies to 5726 ac-ft.[1]

5.2.2 Predicted Flows

Results of the river modeling discussed here are the flows under sceanrios 1, 2, 3, 28, 29, 30, 31, and 32 (see Table 5.2.2). Scenarios 28-32 use the apportionment whereby the U.S. receives 50 percent of the natural flow of the West Fork, 60 percent in the Middle Fork and reservoir releases as scheduled in Apportionment VI in the East Fork (see Table 5.2-1).

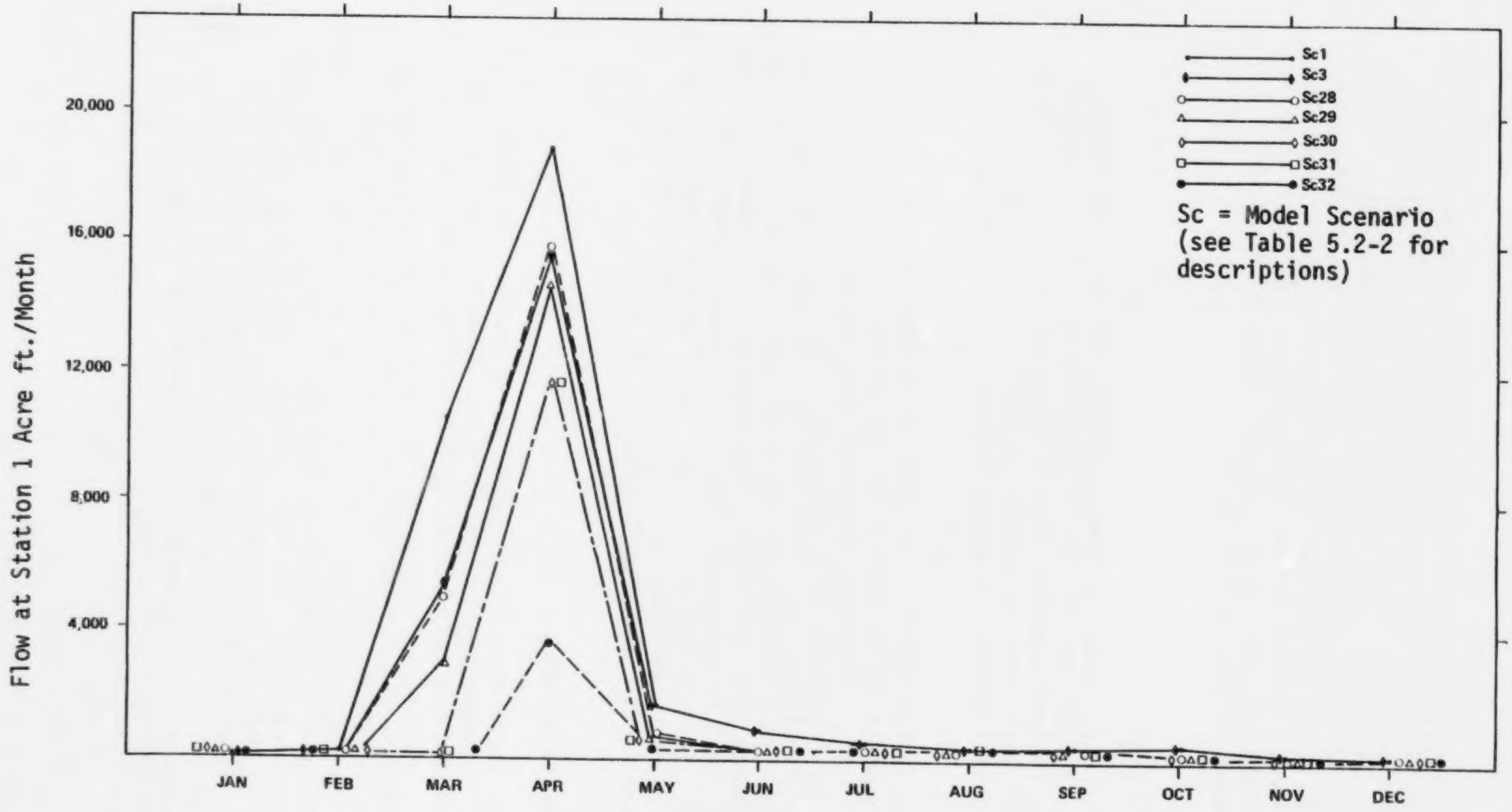
Monthly flows in the Poplar River were calculated for the 10, 50, and 90 percent frequency of occurrence for the scenarios listed above with development (i.e., irrigation, municipal use, domestic use) at specified levels for the years 1975, 1985, and 2000. The percent frequencies indicate the chance that flows will be less than the flows given for that frequency. For instance, in the first plot (Figure 5.2-10) there is a 90 percent chance that the flow at the International Boundary on the East Fork in April will be less than 15,941 ac-ft under scenario 28. Stated another way, in nine out of ten years the flows are predicted to be less than 15,941 ac-ft. The flows at each station at the 10 percent frequency are shown in the Appendix (Figures F-1 to F-5).

5.2.2.1 High Flow Conditions

Monthly flows under high flow conditions (90 percent frequency) at the International Boundary on the East Fork are shown in Figure 5.2-10. The change from scenario 1 to scenario 3 involves the installation of Cookson Reservoir. Essentially only the spring peak flows have been affected under scenario 3. Spring flood peaks are primarily the result of snowmelt. The runoff in 1975 was high so the flows are only decreased by 13 percent. The addition of power plants to the system has the effect of drawing the storage in the reservoir down and thereby decreasing the spillage during peak periods. The model predicts that the spring runoff flows will occur in March or April as occurs under natural conditions. The spring runoff flows on the East Fork occurred in May and June in 76-77 after construction of the reservoir (USGS, 1976, 1977) but in 1978 and 1979 the peak flows were in April as under natural conditions. The late runoff may occur only in dry years.

---

[1] Montana Health and Environmental Sciences Department, 1979.



NOTE: Flows plotted are at the 90 percent frequency. Flows are predicted to be less than those shown in 9 out of 10 years.

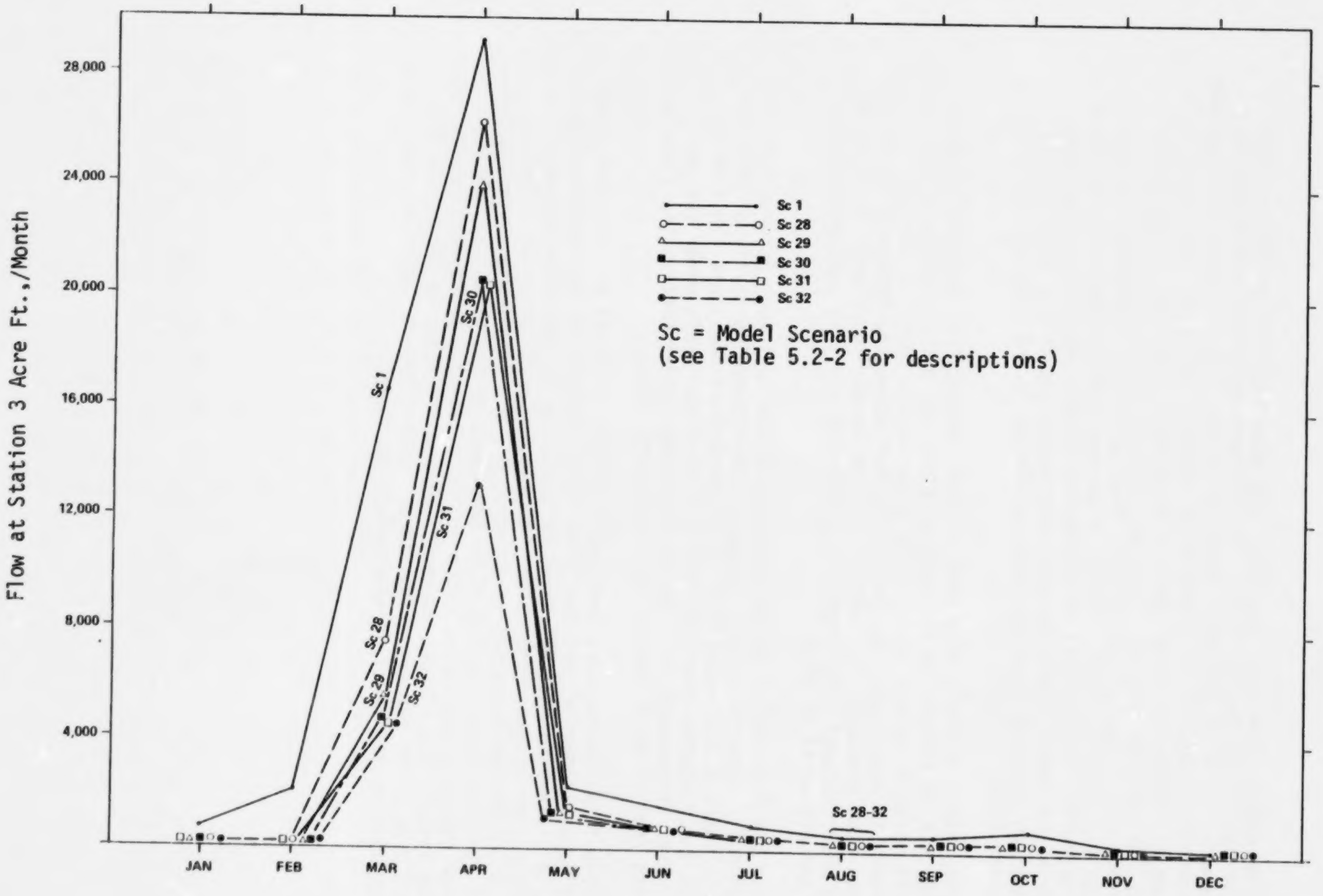
Figure 5.2-10. PREDICTED HIGH FLOWS AT EAST FORK OF POPLAR RIVER AT INTERNATIONAL BORDER

The summer flows are less under the apportionment conditions than natural conditions (scenario 1). The percent reduction from scenario 1 to scenario 29 is 53 percent. Scenario 30 and 31 bring about a 65 percent reduction and scenario 32 causes an 80 percent reduction from scenario 1. In June all scenarios bring about a 63 percent reduction in the natural flows. In July the natural flows are reduced by 35 percent for all scenarios and in August the release flows under all scenarios are the same as the natural flows. Winter flows are higher under the apportionment scenarios than natural or historical flows. Basically, the same patterns that exist under the different scenarios at the International Boundary on the East Fork also are manifested in the flows on the East Fork near Scobey (Figure 5.2-11).

The flows on the Middle Fork at the International Boundary (Figure 5.2-12) are 60 percent of the natural flows for all scenarios under Apportionment VI except scenario 32 (year 2000). Until a storage reservoir is constructed on the Middle Fork above the border as predicted by year 2000 (included in scenario 32) the actual flows will be close to those under natural conditions since only 188 ac-ft is used annually in 1975 and 396 ac-ft in 1985.

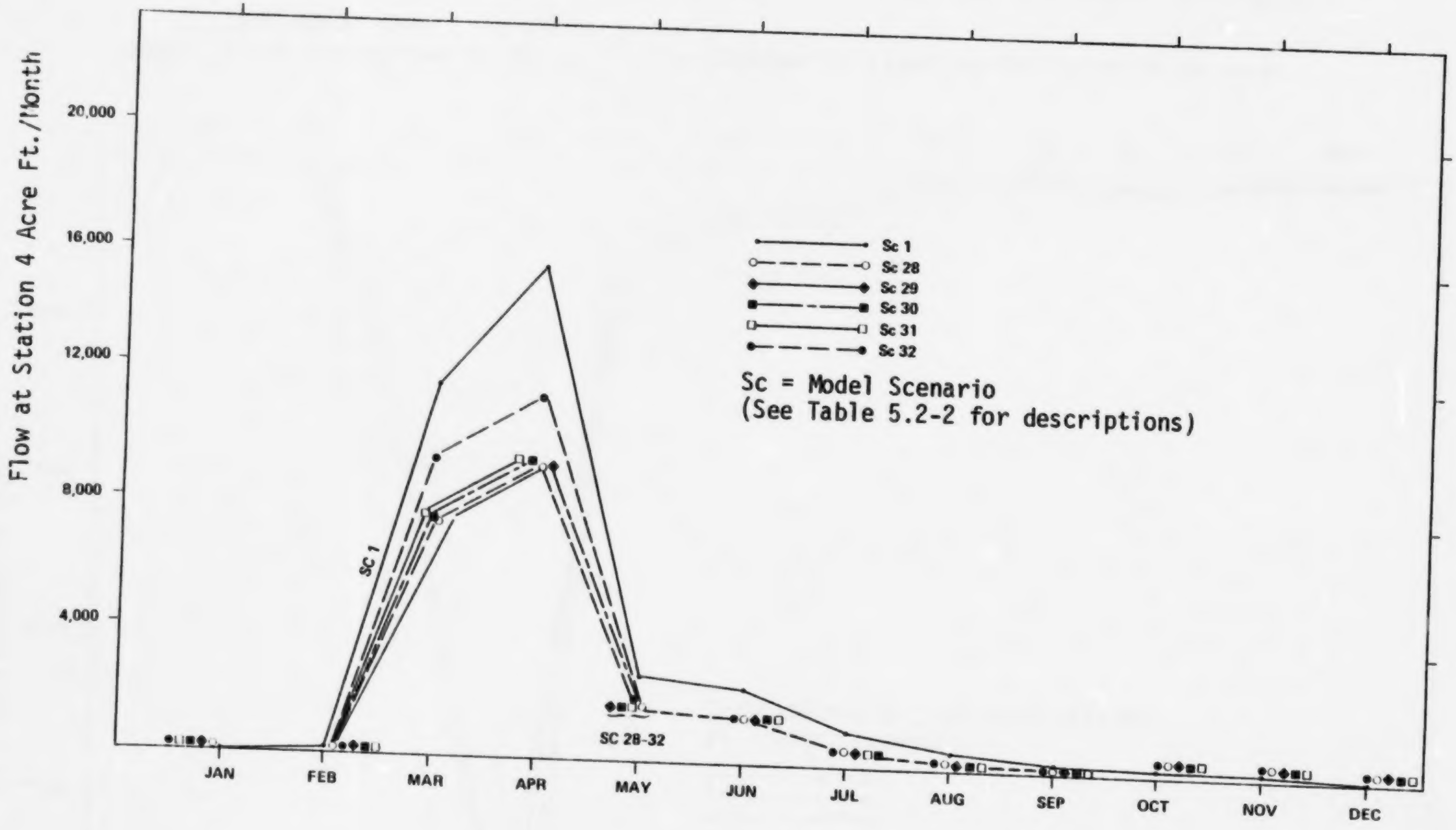
In the Main Poplar at the boundary of the Fort Peck Reservation (station 8), flow reductions increase with increasing levels of development. Figure 5.2-13 shows that in 90 percent of the years the flow in August and September are less than 3.2 ac-ft per month under the year 2000 level of development. During the other summer months, the flows were reduced from 20 to 50 percent of the natural flows.

The flows in the West Fork and tributary (station 9 - Figure 5.2-14) under Apportionment VI are specified as 50 percent of the natural flow. Thus, all scenarios (28-32) have the same flow at the International Boundary. At Poplar, Montana on the Main Poplar (station 12 - Figure 5.2-15), with the exception of scenario 28, all future use scenarios have flows that are less than 3.2 ac-ft per month in the months of October through February due to inclusion in the model of two proposed reservoirs on the reservation. Under scenarios 31 and 32, flows in March are less than 3.2 ac-ft 90 percent of the time. During the spring, flow reductions are greater as the level of development increases.



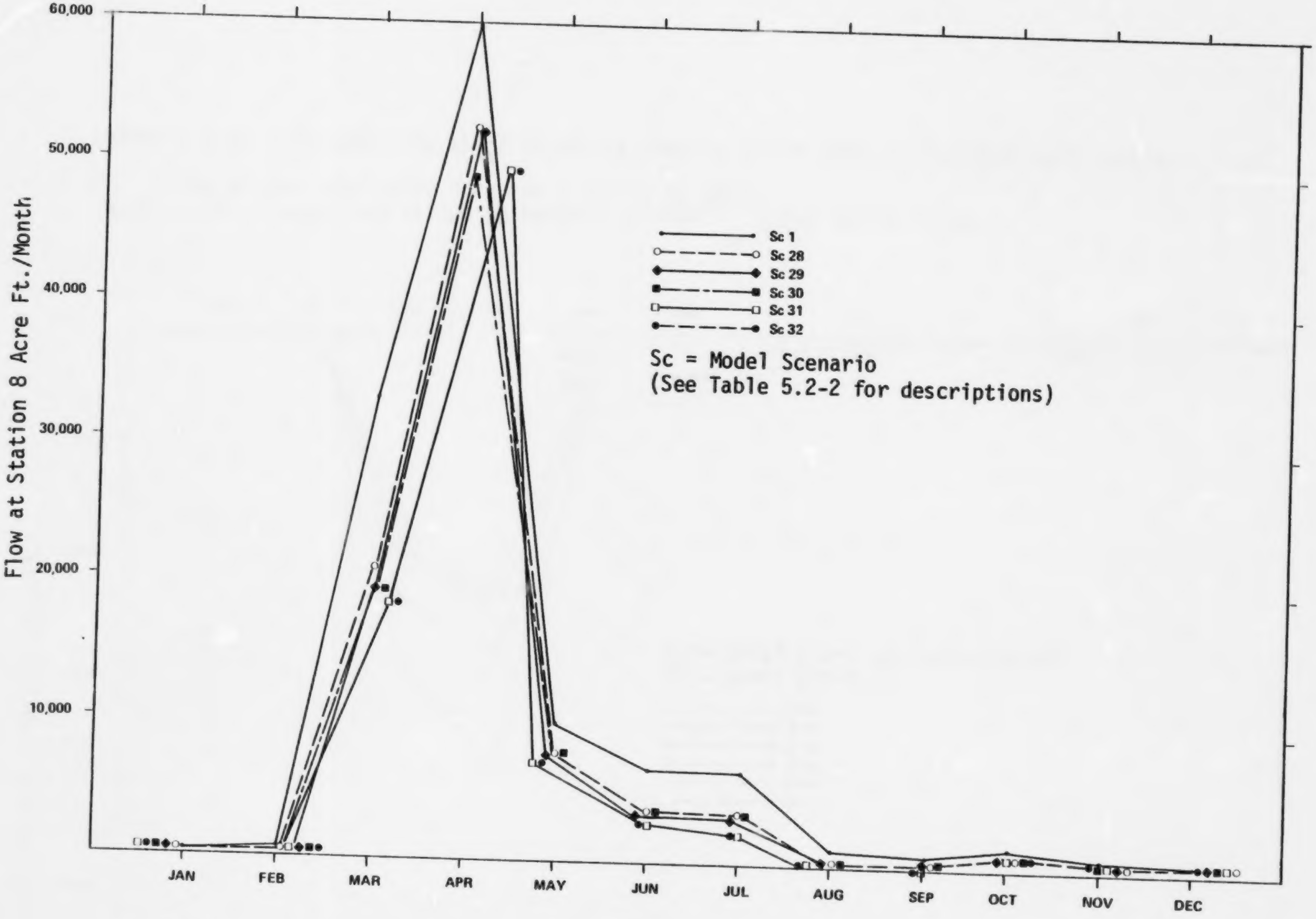
Note: Flows plotted are at the 90 percent frequency. Flows are predicted to be less than those shown in 9 out of 10 years.

Figure 5.2-11 PREDICTED HIGH FLOWS AT EAST FORK OF POPLAR RIVER AT SCOBEY



NOTE: Flows plotted are at the 90 percent frequency. Flows are predicted to be less than those shown in 9 out of 10 years.

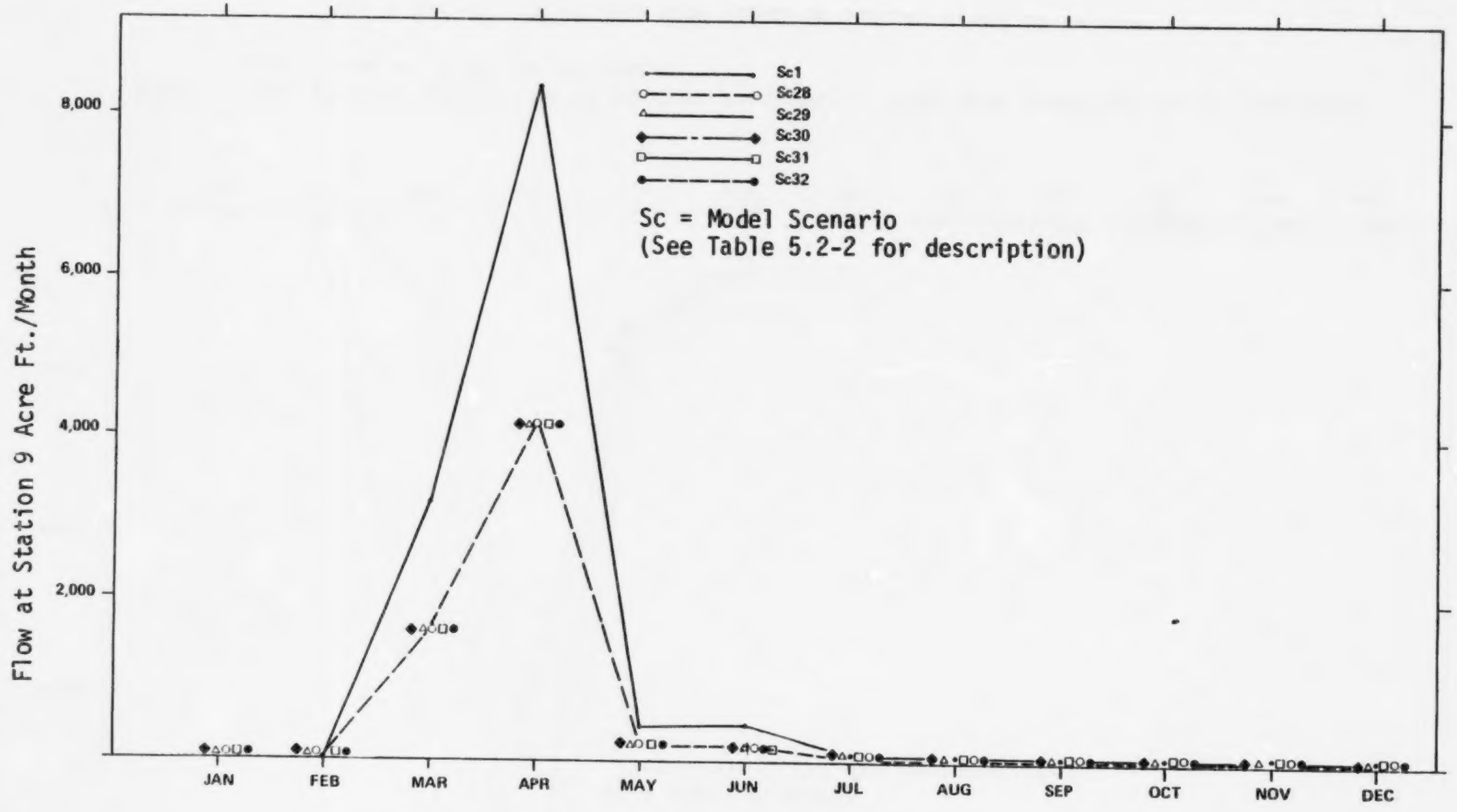
Figure 5.2-12 PREDICTED HIGH FLOWS AT MIDDLE FORK OF POPLAR RIVER AT INTERNATIONAL BORDER



Sc = Model Scenario
(See Table 5.2-2 for descriptions)

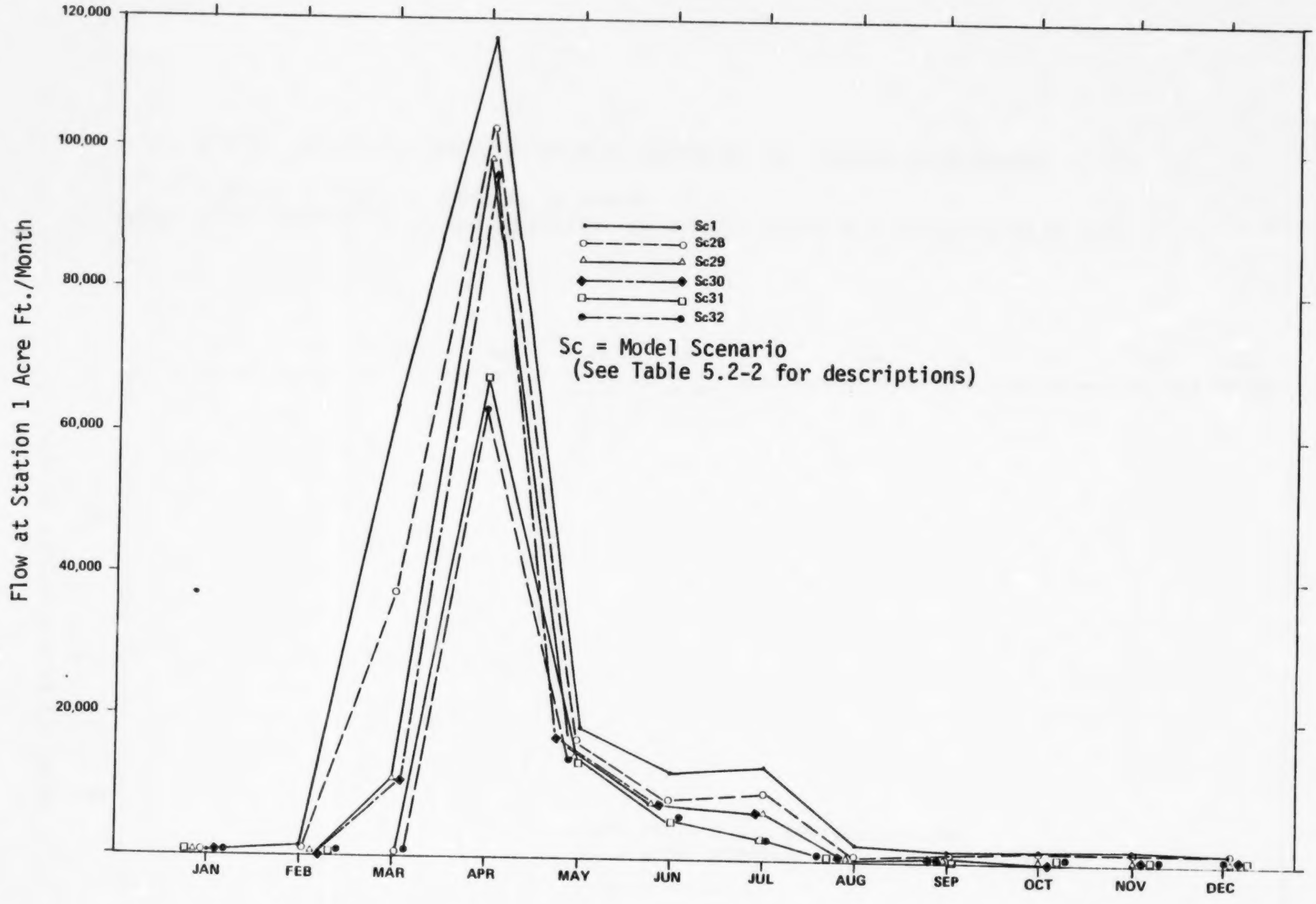
NOTE: Flows plotted are at the 90 percent frequency. Flows are predicted to be less than those shown in 9 out of 10 years.

Figure 5.2-13 PREDICTED HIGH FLOWS OF MAIN POPLAR RIVER AT FORT PECK INDIAN RESERVATION



NOTE: Flows plotted are at the 90 percent frequency. Flows are predicted to be less than those shown in 9 out of 10 years.

Figure 5.2-14 PREDICTED HIGH FLOWS OF WEST POPLAR AT THE INTERNATIONAL BORDER



NOTE: Flows plotted are at the 90 percent frequency. Flows are predicted to be less than those shown in 9 out of 10 years.

Figure 5.2-15 PREDICTED HIGH FLOWS OF POPLAR RIVER AT POPLAR

5.2.2.2 Low Flow Conditions

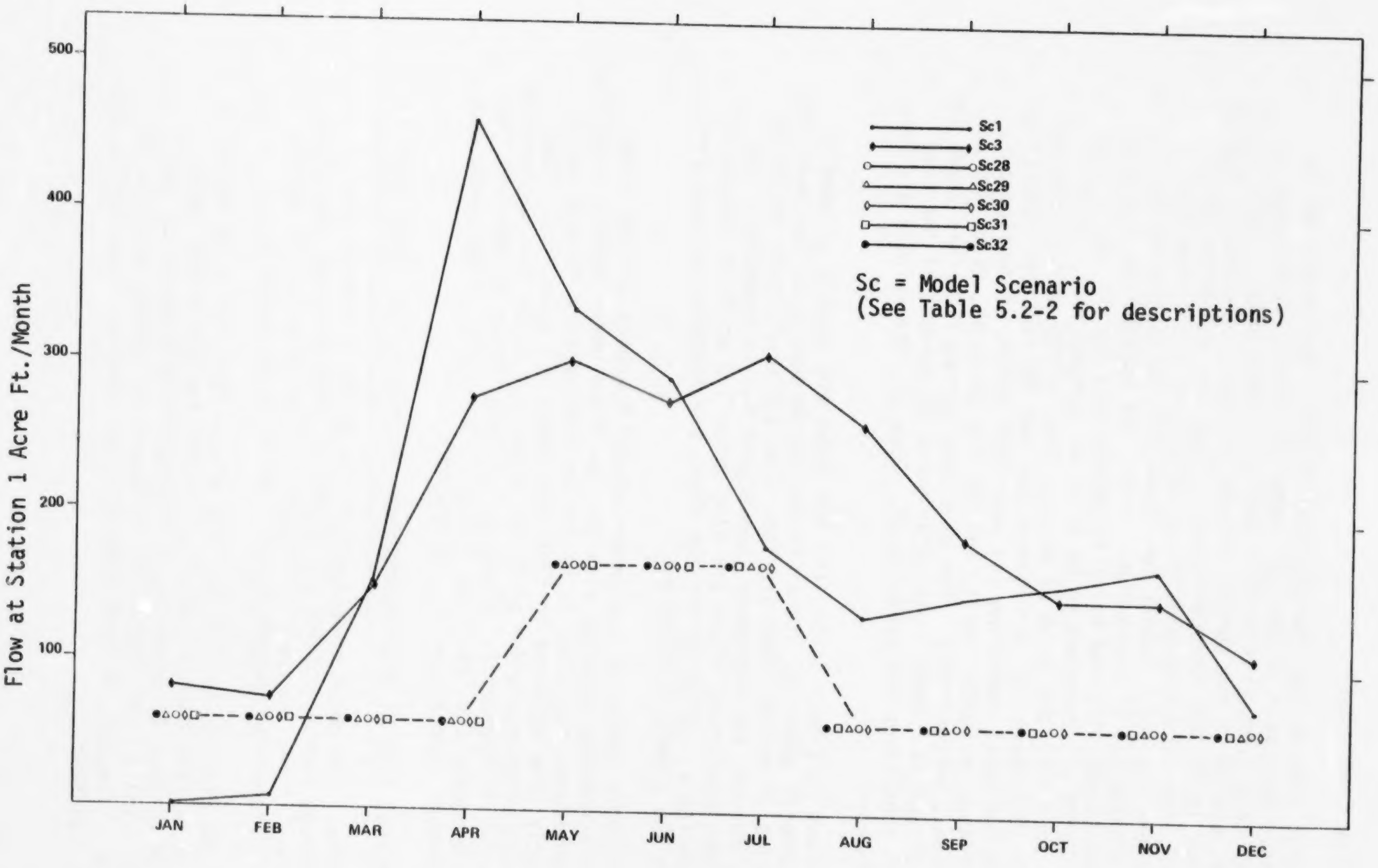
On the East Fork at the International Boundary the effect of installing Cookson Reservoir is seen by comparing natural conditions and post-reservoir conditions (scenarios 1 and 3, respectively). Peak flows generally are reduced in the spring through storage. Groundwater seepage increases flows in October through March. Flows for scenarios 28-32 consist of only the scheduled continuous release of 1 cfs from the reservoir (Figure 5.2-16). Actual low flows will be higher due to groundwater seepage of, at a minimum, 1 cfs. The changes in flow will impact the downstream fish and wildlife populations during the spring. The flows in March are expected to be 52 to 63 percent less, 19 to 88 percent less in April, and 30 to 51 percent less in May with apportionment VI under 1975 levels of development and one 300 MWe unit operating. With four 300 MWe units operating and year 2000 levels of development, the flow decreases in March, April, and May are 63 to 98, 69 to 88, and 42 to 80 percent, respectively. The predicted spring flows are shown in Figures 5.2-17 and 18. Peak flows occur about 30 percent of the time under natural conditions and scenario 28. However, the volumes are less as discussed above.

In the East Fork near Scobey the low flows are capable of meeting water requirements under all scenarios during the months of May and June. Under scenarios 31 and 32 flows are less than 3.2 ac-ft/month in March, April, July, August, and September (see Figure F-1 in Appendix). In March, however, historical flows are also below 3.2 ac-ft 10 percent of the time. During all other months the flows are adequate to meet the demands with the scheduled releases.

On the Middle Poplar at the International Boundary the low flows under future scenarios coincide with the low flows under natural conditions. The model considered the river to be frozen from January through March unless an early thaw occurred in that year under all scenarios. Peak runoff is reduced on the order of 26 to 29 percent under future scenarios (see Figure F-2 in Appendix). Flows on the Main Poplar at the Fort Peck Reservation boundary are less than 3.2 ac-ft per month in March and June through September (see Figure F-3 in Appendix).

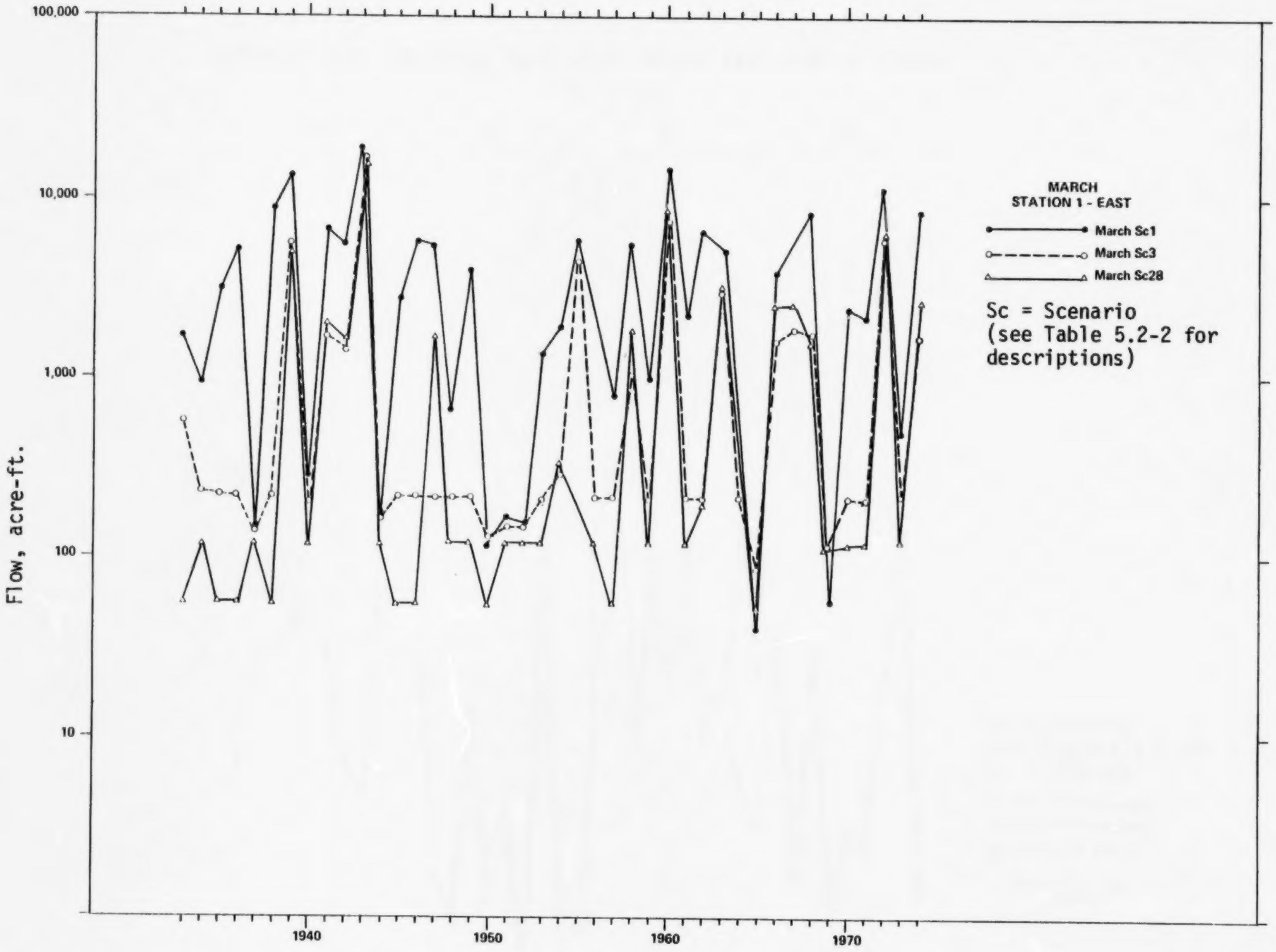
In the West Fork at the International Boundary, low flows under scenarios 28 through 32 are predicted as less than 3.2 ac-ft per month for all months. The model considered the river to be frozen from December through February under all scenarios (Poplar River Task Force, 1976). Natural flows are zero 10 percent of the time for all months except May, October and November (see Figure F-4 in Appendix).

Under low flow conditions the flow of the Main Poplar at Poplar is predicted to be less than 3.2 ac-ft per month for all months under scenarios 29 through 32 depending on the operating schedule of the proposed reservoirs (see Figure F-5 in Appendix). Under scenario 28, flows would be adequate to meet demands in all months except March, July, August and September.



NOTE: Flows plotted are at the 10 percent frequency. Flows are predicted to be less than those shown in only 1 out of 10 years.

Figure 5.2-16 PREDICTED LOW FLOWS AT EAST FORK AT INTERNATIONAL BORDER



Sc = Scenario
(see Table 5.2-2 for
descriptions)

Figure 5.2-17 PREDICTED MARCH FLOWS ON THE EAST FORK 1933-1974

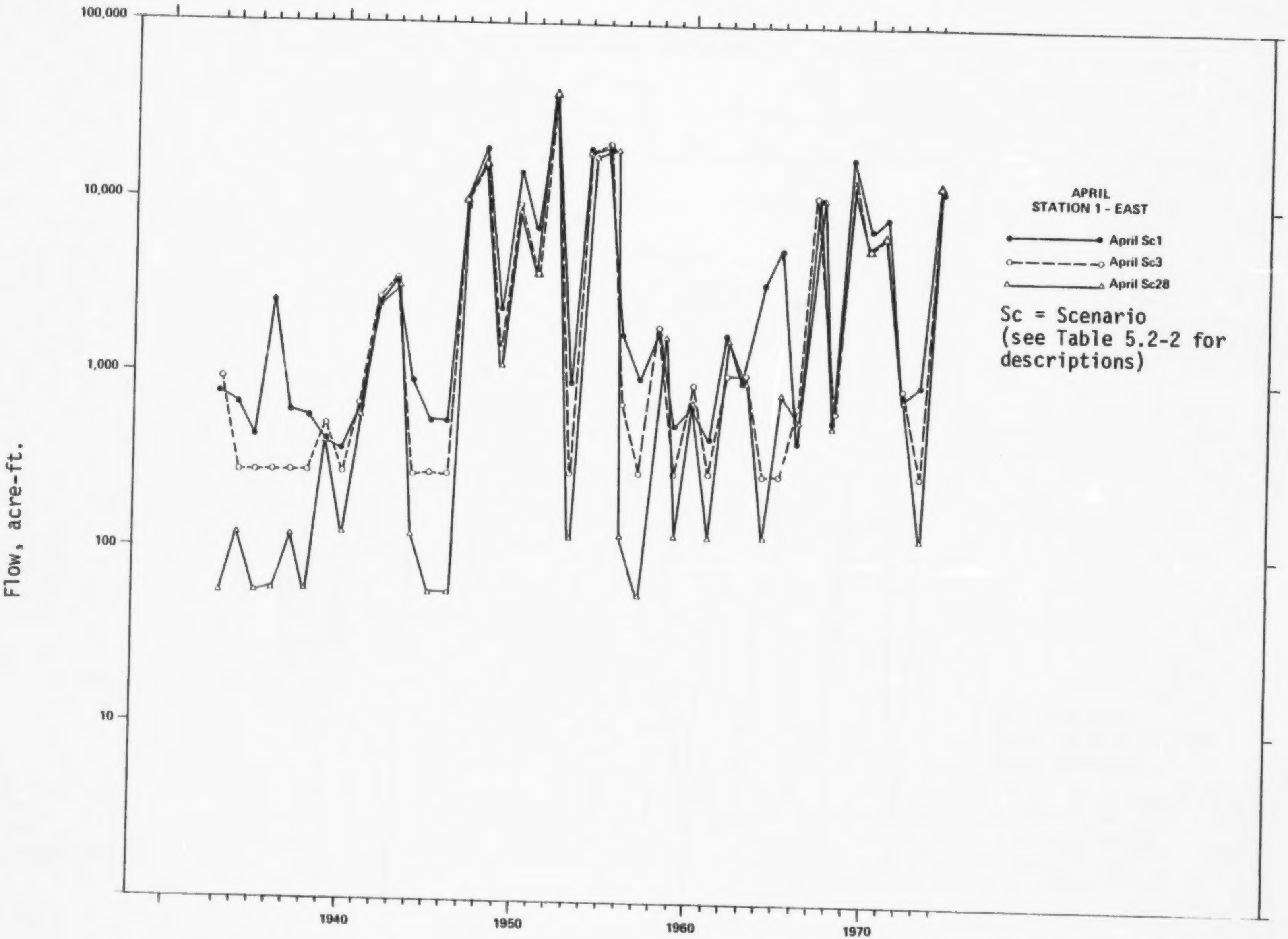


Figure 5.2-18 PREDICTED APRIL FLOWS ON THE EAST FORK 1933-1974

5.2.3 Direct Impacts

5.2.3.1 Municipal Water Supply

The only municipal uses of Poplar River water are for Scobey. The town operates several wells close to the river which receive a large percentage of their recharge from the river. The model used a conservative approach in that all the water is withdrawn from the East Fork (station 3) with no return flow. However, the wells are actually located below the confluence with the Middle Fork so recharge would come partly from the Middle Fork. In addition, there is some recharge from the Flaxville and Fort Union Formations. The municipal demand varies by month as shown below depending on need for outdoor water (e.g., lawn and garden sprinkling, car washing):

	Monthly Demand, ac-ft/month		
	January	July	Total
1975	14	56	350
1985	16	64	400
2000	24	96	600

Ten percent of the time or one in ten years, the flows in March in the East Fork at Scobey are less than 3.2 ac-ft under existing (post-reservoir), historical, and Apportionment VI. The water uses in March (1975) were estimated as 789 ac-ft for spreader irrigation, 105 ac-ft for stock and 17.5 ac-ft for municipal water supply (Karp, 1979). The available water before diversions is estimated as 90 ac-ft (from model results at stations 1 and 2 and groundwater accretion (36 ac-ft)). Thus, the municipal demand could be met with an additional 72.5 ac-ft left over which could be used for instream uses, stock, or irrigation. The municipal demand for March is expected to increase to 20 ac-ft in 1985 and 30 ac-ft in 2000. Thus, the water available for irrigation would decrease to 77.7 and 62.7 ac-ft which would supply about 87 and 75 acres, respectively. The model overestimated the impact since at minimum an additional 24.3 ac-ft and 8.1 ac-ft of water would be available from the Middle Fork in 1985 and 2000, respectively. Flow in April is adequate under 1975 and 1985 levels of development but not for year 2000 uses. The municipal demand would be 36 ac-ft. This demand could be met out of the estimated available water of 90 ac-ft, leaving 54 ac-ft for other demands including stock and spreader irrigation.

Flows in August and September were adequate to meet demands for 1975 and 1985 but not for year 2000. The water uses for year 2000 are estimated as follows:

Uses	August	September
Flood Irrigation	146.4	62.7 acre-feet
Municipal	90	60
Available Water	90	90

The municipal demands are higher in these months reflecting outdoor uses for a total of 250 gallons per capita/day. The municipal demands can be met if all the water was withdrawn for municipal purposes. This is unrealistic as some flow is needed for instream uses. The inability to meet the high summer water demands could be resolved by drilling another well away from the river or encouraging the public to conserve water. Some water could come from the Middle Fork although flows are less than 3.2 ac-ft 50 percent of the time for historical and existing conditions. In some years flows have been less than 3.2 ac-ft on the East Fork at Scobey in late summer.

5.2.3.2 Uses Dependent on Spring Runoff

Spring runoff peak flows are expected to decrease under apportionment at all the border stations but will decrease the most on the East Fork (see Figures F-6, F-7, F-8, and F-9 in Appendix). The peak flows supply water for filling stock reservoirs and irrigating land by the spreader method. Because most of the peak flow is derived from snowmelt, the quality is better than in the summer. The effect of the reservoir on quality of the peak flows is discussed in Section 4.5.1. The peak flows also scour the river channel and clean out sediment deposited under low flow conditions. This scouring function is important in maintaining fish and wildlife habitat as will be discussed in more detail in Section 5.6.4.

Model output gives the volume of discharge in ac-ft rather than a peak discharge in cfs. Flow data for two years since the Cookson Reservoir was constructed provide an indication of what daily peak flows might be on the East Fork. The flows in March, 1976, reached a maximum of 827 cfs. The peak flows in the 76-77 water year came in May with peak flows of only 58 cfs. The peak flows in the 78-79 water year in April were 270 cfs. The variability of peak flows occurs also under natural conditions (see Figures 5.2-13 and 5.2-14). Water demands on the East Fork between stations 1 and 3 include 789 ac-ft for spreader irrigation and 105 ac-ft for stock. One year out of ten the full demands cannot be met in 1975, 1985, or 2000. If the maximum amount was used for irrigation in 1975 about 87 acres could be irrigated instead of the total of 1,023 acres. The lack of adequate supplies for irrigation and filling stock reservoirs in March is less serious if adequate flows occurred in April or May. In four of the nine years with low flows in March, the main runoff came in April. In the other five years of low spring runoff, most of the runoff occurred in March. The water available in April for these uses and instream flows is adequate in 1975 and 1985 but not year 2000. The available water would be 54 ac-ft which would not meet the total projected demand of 816.2 ac-ft. These low flows occurred in five out of 43 years when all but one year had a low spring runoff.

March flows on the main Poplar (station 8) are less than 3.2 ac-ft 10 percent of the time for historical and existing conditions and Apportionment VI. This is not surprising since flows at station 3 further upstream at Scobey are also this low 10 percent of the time. Minimum available water from the Middle Fork varies between 8 and 24.7 ac-ft for Apportionment VI. The demands for water at station 8 include 334 to 465 ac-ft for stock/domestic uses and 287.6 to 816.8 ac-ft for spreader irrigation. These demands appear to be high since the estimated natural flow was only 186 ac-ft 10 percent of the time. However, stock reservoirs are filled mostly from smaller tributaries to the main forks of the Poplar River whenever the spring runoff occurs.

Prior to construction of two reservoirs on the Fort Peck Indian Reservation, March flows at Poplar (station 12) are less that 3.2 ac-ft 10 percent of the time under historical, existing and the proposed apportionment conditions. Thus, the spreader irrigation demand of 228.8 ac-ft would not be met 10 percent of the time. April flows would be less than 3.2 ac-ft 10 percent of the time in 1985 and 2000 but no diversions are required although there would be impacts on fish and wildlife. Available water flowing into the reservoirs in dry years (one out of ten years) from October through March would be about 2,000 ac-ft in 1985 and 1,652 ac-ft in 2000. The stock and domestic demand of 802 ac-ft could be met and 1,199 and 850 ac-ft would be available for irrigation in 1985 and 2000, respectively. This amount could supply 450 acres in 1985 and 319 acres in 2000 if no carryover storage is included.

Stock and spreader irrigation demands can be met on the Lower Middle Fork (station 7) and Lower West Fork (station 11). Flows on the Upper West Fork (station 9) are considered to be below 3.2 ac-ft by the model due to freezing in March and April under natural, historical, and apportionment conditions one year out of ten but there are no diversions for water uses.

5.2.3.3 Summer Flows

Summer flows are diverted for flood and sprinkler irrigation. The model distributed the demand according to the monthly schedule shown in Tables E-1 and E-2 in the Appendix. The estimated actual and projected acreages under irrigation were compared to the number of acres which could be irrigated with the available water based on four applications per year with an average of 6.1 inches per month. The information will be summarized below with the complete table included in the Appendix (Table F-1). This is a worst case since the average number of applications per year has been 2.4 under historical conditions with little or not irrigation in August and September. The model may also overestimate the impact on irrigation in the summer because it did not consider pumping of groundwater from deep pools in the river. This groundwater is in addition to the average groundwater accretion which was included in the model. Where this type of irrigation is practiced, irrigation could continue even when the flow in the river appears to be very low.

Irrigation demands on the Upper East Fork can be met from a quantity standpoint in 1975 and 1985 at least 90 percent of the time. The demand for irrigation of 1,533 acres in the year 2000 exceeds the available supply in August and September. Flows have been less than 3.2 ac-ft 10 percent of the time under historical and existing conditions. The number of acres that could be irrigated in these months is about 188 depending on the method and extent of municipal uses.

Flows in the upper Middle Fork (station 4) are less than 3.2 ac-ft in August and September, an estimated one out of ten years, for Apportionment VI as well as for natural and existing conditions but there are no diversions.

Flows in the Lower Middle Fork (station 7) are less than 3.2 ac-ft 10 percent of the time in June for the historical, existing, and apportionment conditions. The rest of the summer can be even drier with flows less than 3.2 ac-ft 50 percent of the time in July and 90 percent of the time in September under existing and apportionment conditions. Net irrigation requirements are as follows:

	1975	2000
June	381.1 acre-feet	674.2 acre-feet
July	522.4	1051.7
August	412.8	833.5
September	137.6	280.6

Only a part of this demand could be met at the ten percent frequency even under natural conditions when only 194.4 (June), 32.4 (July), and 8 ac-ft (August and September) would be available. Fewer irrigation applications under 1975 conditions would be made since only 408 acres could be irrigated in June, 344 in July, 36 in August and none in September. The full irrigation demand could be met in June more than 50 percent of the time but less than 50 percent of the time in July and less than 10 percent of the time in August and September.

During the summer months of June to September, flows on the Main Poplar (station 8) are less than 3.2 ac-ft one out of ten years under the proposed apportionment and historical and existing conditions. For the year 2000 level of development the flows for August and September are less than 3.2 ac-ft in 40 out of 42 years. Water demand in June for irrigation in 1975 was 472.9 ac-ft. This is estimated to increase to 810.9 ac-ft by the year 2000 which is more than the 640 ac-ft under natural conditions. Available water would provide about half of the 1975 demand and could irrigate about 708 acres depending on the type of crop and irrigation method used. For the year 2000 the available water could irrigate about 440 acres. Irrigation demand in July was 718 ac-ft in 1975 and is projected to increase to 1248 ac-ft in the year 2000. Under the proposed apportionment, the number of acres which could be irrigated averages 492 in 1975 and 24 in 2000. The available water is much less than the net irrigation demand of 560.7 ac-ft in 1975 and 982.3 ac-ft in 2000. The response of farmers in dry years such as these would most likely be not to irrigate the third and fourth time. The case in September is similar with a net irrigation demand of 199.8 ac-ft in 1975 and 322.5 ac-ft in 2000. The number of acres which could be irrigated is 172 in 1975 and 148 in 1985.

Flows on the Upper West Fork (station 9) are less than 3.2 ac-ft ten percent of the time under historical, existing, and the recommended apportionment conditions in March, April, August, and September. No diversions are made from the river at station 9. As expected, flows in the Lower West Fork (station 11) are less than 3.2 ac-ft in August and

September under historical, existing, and the proposed apportionment. By the year 2000, May and June flows are estimated to be less than 3.2 ac-ft 10 percent of the time. Water uses for irrigation include 356.2 ac-ft in May and 582.8 ac-ft in June in 2000. These demands cannot be met 10 percent of the time since there is little available water from upstream. Full irrigation demands in July cannot be met 50 percent of the time in 1985 and 2000, with water available in 1985 to irrigate only about 24 acres. August and September flows are less than 3.2 ac-ft 10 percent of the time under historical, existing, and the apportionment scenarios. For September in the year 2000 the flow is less than 3.2 ac-ft 100 percent of the time if maximum available water was withdrawn. The irrigation demands are as follows:

	August	September
1975	204.2 acre-feet	70.2 acre-feet
2000	725.3	246.1

Water would be available to meet these demands less than 50 percent of the time. The water available less than 10 percent of the time could irrigate about 48 acres.

Meeting the 1975 irrigation demands during the summer on the Fort Peck Indian Reservation is possible 50 percent of the time. The full demand can be met 10 percent of the time in June and September. In July only about 296 acres can be irrigated instead of 618 acres. In August limited water is available for irrigation.

Expansion of irrigation is projected based on construction of two reservoirs on the Main Poplar. The design capacity of these reservoirs is 152,400 ac-ft (Morris-Maierle, 1978). After construction of the reservoirs, the projected demand in 1985 for 10,618 acres can be met at least 50 percent of the time. The irrigation demand in 2000 for 20,618 acres can be met if carryover storage from wet years in included or if irrigation is delayed until May.

Releases below the two new reservoirs are needed for flood irrigation. Flows in May and June are adequate to meet demands in 1975 but not in 1985 and 2000 at least 10 percent of the time. Water used for flood irrigation is estimated to be 39 ac-ft in May and 64.3 ac-ft in June. Flows in July and August are less than 3.2 ac-ft under historical, existing, and Apportionment VI 10 percent of the time so the flood irrigation demands of 99.7 ac-ft in July and 78.7 ac-ft in August would not be met. The September water demand of 26.2 ac-ft for flood irrigation could be met in 1975 but not in 1985 or 2000 at least 10 percent of the time. Water could be made available if small releases were made in the summer during the low-flow years.

5.2.3.4 Winter Flows

Winter flows are needed to maintain the fish and wildlife habitat. The upper reaches of the Poplar River can freeze. The model simulated these conditions by setting the flow equal to "zero". Flows on the Middle Fork at the international boundary (stations 4, 5, and 6) were set as "zero" by the model from January through March unless an early thaw occurred for that year. Flows on the West Fork and tributary at the international boundary (stations 9 and 10) and on Cow Creek (station 2) were assumed to be "zero" from December through February. These model conditions were based on findings of the Poplar River Task Force (1976, Appendix B). The impacts of low winter flows are discussed in Section 5.6.4.2.

5.2.4 Impacts on Groundwater Levels

Groundwater throughout the basin is used for domestic water supplies, stock watering, and to a limited extent irrigation. The analysis of impacts in this EIS is restricted to the U.S. part of the basin. Impacts due to changes in flow regime may be caused by dewatering of the mine site, leakage from the ash disposal ponds, and leakage from Cookson Reservoir. The primary effects of these activities will occur in the Canadian part of the basin and so are not discussed. The predicted impact of these activities on groundwater in Montana will be discussed. The maximum predicted decline in water levels in the Fort Union Formation due to dewatering at the border directly south of the mine site is 0.7 m after 35 years. Existing well pumps may need to be lowered depending on specific conditions at a well.

The maximum rise due to leakage from the reservoir at the border is predicted to be 0.1 m after 75 years (IPRWQB 1979). The higher water level near the East Fork at the border could result in new areas of saline seep. In general, the decline in groundwater level would result in decreased seepage to the East Fork but this would be offset by the increase in seepage from the reservoir and over the long term by the seepage from the ash lagoons. The effect of these changes on water quality of the East Fork are discussed in Section 5.3.

5.3 WATER QUALITY IMPACTS

5.3.1 Description of Quality Models

Water quality in the Poplar River was simulated using Karp III and the Modified Montreal Engineering (MME) model of the Cookson Reservoir. Appendix D includes a detailed description of both of these models. The quality at border, Poplar Reservoir, and downstream stations was modeled differently. The basic method was to develop regression equations for specific conductivity or total dissolved solids (TDS) based on the average monthly discharge. Regression equations were then developed to predict sodium, sulfate, boron, and hardness concentrations from TDS. At downstream stations a mass-balance approach is used. The water quality is calculated from the quality of upstream water plus any groundwater seepage, irrigation return flow, or runoff. Average yearly groundwater quality and seepage flows were used for each station. The TDS content of surface irrigation return flow was calculated at 10 percent higher than the TDS of the diverted water due to evaporation and salt pickup.

A hypothetical reservoir on the Middle Fork of the Poplar River in Canada was included in the year 2000 scenarios to meet Canadian water demands. The quality in this reservoir was based on mass-balance of all inflows and outflows and complete mixing in the reservoir. The quality of the outflow was calculated as the average of the reservoir quality at the beginning and end of the month. The model obtained additional water from this hypothetical Poplar Reservoir if needed to meet the flow apportionment rather than Cookson Reservoir.

The Cookson Reservoir was simulated by the MME model (described in Saskmont Engineering, 1978). The model input includes natural and forced evaporation, tributary inflows, direct precipitation, ash lagoon discharges, mine dewatering discharges, power plant releases, and groundwater seepage. Overflows from Fife Lake occurred in March through October of 1952-54. The model includes power plant operations such as addition of sulfuric acid for reverse osmosis treatment of boiler feedwater, demineralization, and chlorination of condenser cooling water. The effects on the ash lagoons of these processes are modeled for each lagoon as if it were a separate reservoir. The outflow from the ash lagoons was modeled as partly surface flow to the reservoir and partly subsurface flow into the East Fork between the dam and the border. The outflow quality from the reservoir is determined by complete mixing of the reservoir and mass balance of all reservoir inflows and outflows. The appropriate releases are made with the quality equal to the resulting quality of the reservoir at the end of the month. The quality at the East Fork border station is used as input for the river quality model, Karp III.

The MME model was used to simulate the original plan of operation of the ash lagoons when a maximum of 30 ac-ft/month of subsurface flow discharged to the East Fork between the dam and the border and ash lagoon decant was discharged to the Cookson Reservoir. These model results (scenarios 4A and 8A) represent a worst case. The present plan of operation which involves lining the lagoons with clay is expected to limit seepage to the East Fork to 2 liters/sec or 4.2 ac-ft/month. The ash lagoon decant will be recirculated. The other scenarios (28-32) included natural and forced evaporation from Cookson Reservoir but not the ash lagoon seepage as simulated by the MME model.

Using model results a discussion is presented below regarding effects of power plant operation and apportionment on criteria and standards associated with irrigation, stock watering, and human consumption uses. Effects on aquatic life and secondary impacts on agricultural land use are discussed in Sections 5.6.3 and 5.5, respectively.

Figure 1.2 shows stations where projected water quality simulation results are available. In terms of irrigation and stock watering uses, as well as impacts of power plant operation, the stations of interest are 1, 3, 8, and 12. For potable water supply use, stations 3 and 7 are important. This is the case because the Town of Scobey draws its water from the East Fork (below the confluence with the Middle Fork). The Town of Poplar uses groundwater. The remainder of the system, while having altered flows, will have only nominally altered quality.

For purposes of the primary impacts discussion, modeling scenarios 2 and 3 and 28 through 32 are considered. It is important here to note the following: scenario 2 represents historical, pre-Cookson Reservoir in-place. Scenario 28 represents 1975 conditions with one 300 MW unit in operation. Scenarios 29 and 30 represent projected 1985 conditions with two and three 300 MW units, respectively. Scenarios 31 and 32 represent year 2000 conditions with three and four 300 MW units, respectively. Scenarios 4A and 8A with one and two 300 MW units, respectively, are also discussed as a worst case.

5.3.2 Boron

Trace amounts of boron are required by plants but high concentrations can be toxic. Thus, concentrations in water used for irrigation are important. The months during which most irrigation occurs in the Poplar River Basin are April through September, inclusive. Boron concentrations on the East Fork at the border during January 1976 through September 1978 ranged between 0.12 mg/ℓ and 2.0 mg/ℓ. From March to December 1975 boron concentrations were between 1.0 and 3.1 mg/ℓ (U.S.G.S. data). The IJC has proposed objectives for March through October specifying a long-term flow-weighted average boron concentration of 2.5 mg/ℓ and a maximum flow-weighted average concentration during any three consecutive months of 3.5 mg/ℓ. The impacts of the increased boron concentrations are discussed both for scenarios 28 through 32 which do not include the ash decant and scenarios 4A and 8A which do. The concentrations at stations 1, 3, 8, and 12 are discussed for both types of scenarios. Summary tables of model output are included in Appendix G. The impacts of these concentrations on drinking water supplies, crops (alfalfa, barley, oats, and wheat) and livestock are discussed in the following sections.

Predicted model results for boron concentrations decrease in the downstream direction as shown in Figure 5.3-1. Scenarios 28 and 29 represent the more likely cases. Boron concentrations for stations 1, 3, 8, and 12 for scenarios 28 and 29 are 2.5 mg/ℓ or less during the irrigation season and a maximum of 2.7 mg/ℓ during the winter. At the East Fork border station (#1) the concentrations for scenario 31 with three 300 MW units could reach 3.6 mg/ℓ during the irrigation season and 4.1 mg/ℓ in the winter. For the year 2000 with four 300 MW units (scenario 32) predicted boron concentrations at station 1 are between 3.8 and 8.0 mg/ℓ at the 90 percent probability level. Boron concentrations at the East Fork at Scobey at the 90 percent probability level in the irrigation season are 2.4 mg/ℓ or less with three 300 MW units and 3.2 mg/ℓ or less with four 300 MW units. In the winter concentrations at the 90 percent probability level are predicted to be 4.5 mg/ℓ and 6.3 mg/ℓ with three and four 300 MW units, respectively. The predicted boron concentrations at stations 8 and 12 are below 2.5 mg/ℓ for both three and four 300 MW units.

As a worst case, boron concentrations are predicted with the ash decant included (scenarios 4A and 8A) (Figure 5.3-2). The resultant concentrations during the irrigation season are discussed for stations 1, 3, 8, and 12. The concentrations at station 1 with one 300 MW unit are between 3.7 mg/ℓ at the 10 percent probability level and 7.5 mg/ℓ at the 90 percent probability level during the irrigation season. With two 300 MW units the concentrations increase at station 1 for the same probability levels above to 3.6 mg/ℓ and 13.9 mg/ℓ. At station 3 with one 300 MW unit the concentrations range between 1.1 mg/ℓ at the 10 percent probability level and 6.5 mg/ℓ at the 90 percent probability level and between 1.0 and 11.4 mg/ℓ with two 300 MW units. Concentrations at station 8 exceed 4 mg/ℓ only with two 300 MW units at the 90 percent probability level. Concentrations at station 12 are below 4 mg/ℓ at all probability levels.

5.3.2.1 Boron Impacts on Crops

The effects of boron toxicity on crop-soil systems are poorly defined partly because the soil-water-plant system is so complex and variable. Experimental data are sparse and are collected under a variety of soil and climatic conditions. Soil chemical data were available at a limited number of locations, mostly adjacent to the Poplar River and only a few water quality parameters were modeled. For these reasons the crop yield changes presented here should be considered as best estimates for comparative purposes only. The crops studied were alfalfa, wheat, barley, and oats.

Compared to salinity and sodicity few studies have been performed relating to boron toxicity. Only three studies were found that related boron (B) in the soil solution or irrigation water to the yield of alfalfa, wheat, barley or oats. Eaton (1944) grew alfalfa, barley, and oats using irrigation water with boron concentrations ranging from a trace to 25 mg-B/ℓ. Fox (1968) showed that calcium treatments had no effect on alfalfa grown with boron concentrations in the nutrient solution ranging from 0.25 to 32 mg-B/ℓ. Yields, on the average, decreased with the increasing boron concentrations. Chauhan and Powar (1978) had decreasing wheat yields when boron concentrations in the irrigation water increased from 0.5 to 8 mg-B/ℓ.

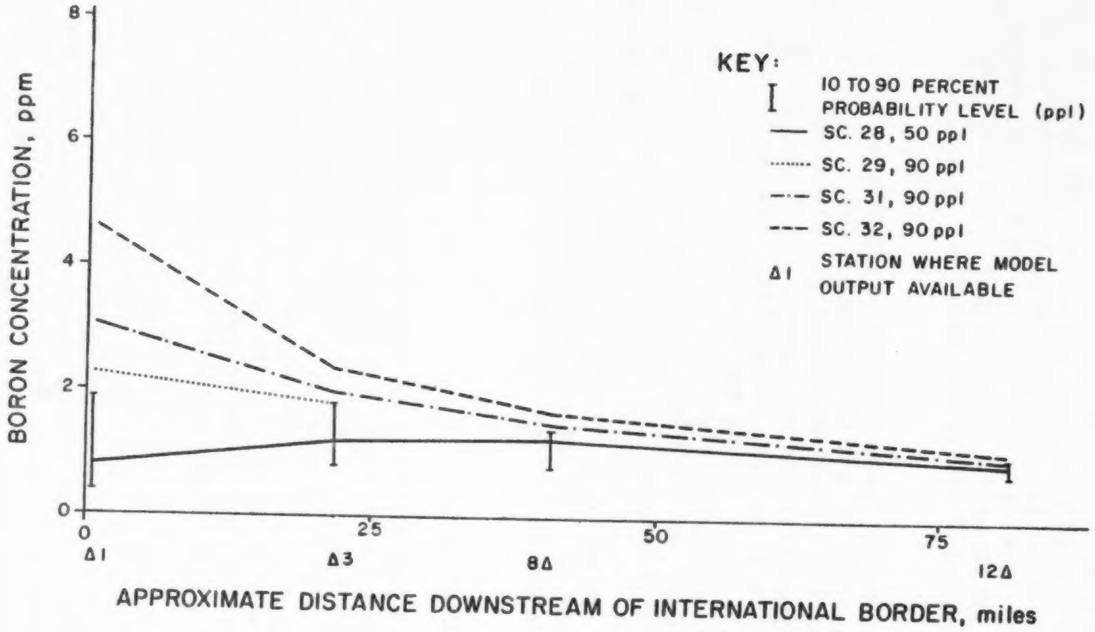


Figure 5.3-1 BORON CONCENTRATIONS IN JULY ON EAST FORK AND MAIN STEM OF POPLAR RIVER FOR SCENARIOS 28, 29, 31, AND 32

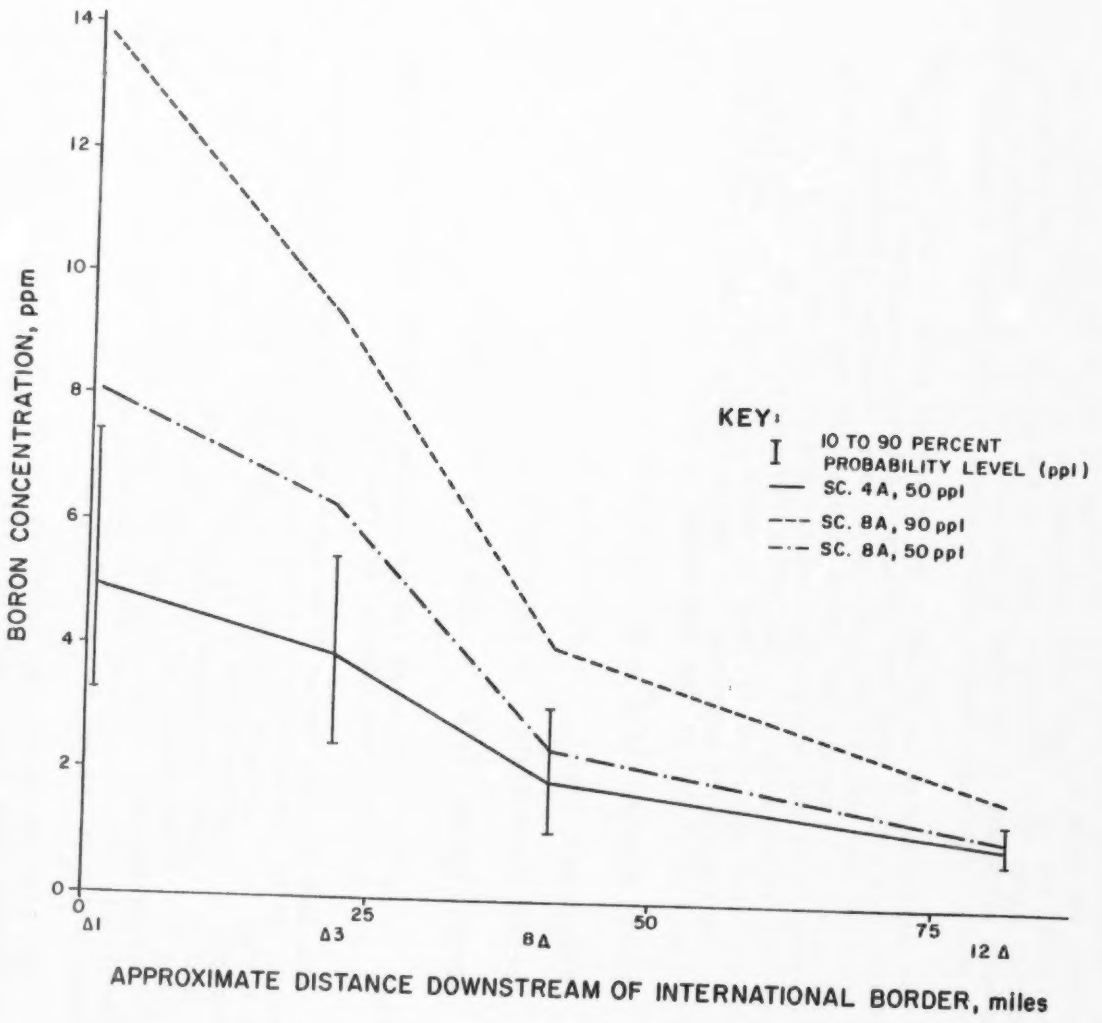


Figure 5.3-2 BORON CONCENTRATIONS IN JULY ON EAST FORK AND MAIN STEM OF POPLAR RIVER FOR SCENARIOS 4A AND 8A

Other work done by Hatcher, et al. (1959) showed that plants respond to soluble boron in the soil solution and not to that adsorbed or held in mineral complexes. When irrigation waters containing boron are applied to soils some of the boron is adsorbed. Therefore it is difficult to determine the amount of boron that the plant is actually responding to. In the experiment of Chauhan and Powar (1978) the soil solution concentration of boron was measured. At low concentrations of added boron the soil solution concentration exceeded the concentration in the irrigation water. However at high concentrations of added boron the solution concentration was only half the concentration in the irrigation water. Eaton (1944) and Fox (1968) only measured the boron concentration in the irrigation water therefore their data are subject to some interpretation since some boron may be adsorbed by the soil and is not available directly to the plant. Boron adsorption is discussed in more detail in Appendix G.

The approach used to estimate the effect of boron on crop yields was to develop regression equations between the boron concentration in the soil solution and the percent yield using data from the literature. Alfalfa appears to be the most boron tolerant of the four crops based on the projection of the regression line to zero yield (see Figure G-1 through G-4 in Appendix G). The zero yield projection for alfalfa is 33 mg-B/ℓ (soil solution) followed by wheat (12), oats (10), and barley (7.0). The regression equations for percent yield of these crops with mg-B/ℓ (soil solution) as the independent variable are:

$$\text{Percent Alfalfa Yield}^{*} = 89 - 2.7\,B \quad (r = -0.56)$$

$$\text{Percent Oats Yield} = 75 - 7.2\,B \quad (r = -0.78)$$

$$\text{Percent Wheat Yield} = 106 - 8.7\,B \quad (r = -0.95)$$

$$\text{Percent Barley Yield} = 86 - 9.4\,B \quad (r = -0.91)$$

*Note: In reality zero boron concentrations would not result in maximum yield since trace amounts are required.

The data for the Poplar River Basin were obtained in the following manner. Boron concentrations in the irrigation water were averaged over the period April through September for stations 1 and 3 for the East Fork sub-basin and stations 8 and 12 for the Fort Peck Reservation at the 90, 50, and 10 percent cumulative probability level for scenarios 3, 4A, 8A, 28, and 29. Boron concentration in the soil solution was estimated by an equilibrium approach using Langmuir adsorption constants (for details see Appendix G). The diluting effect of growing season precipitation was then accounted for at the 90, 50, and 10 percent probability levels.

The dilution factor was determined using precipitation from Scobey. The seasonal water requirement for alfalfa (from May to September, assuming that in the month of April the soil will retain sufficient moisture from snowmelt, requiring no irrigation) is 31.7 inches. This number is computed by using a modified Blaney-Criddle method. Subtracting the 90, 50, and 10 percent probability effective rainfall magnitudes from the total consumptive use requirement give the 90, 50, and 10 percent irrigation requirements for this crop.

Similarly, irrigation requirements for oats, wheat and barley (expected irrigation season from May through July) can be determined. The dilution factor can be calculated for these crops at each rainfall probability level (Table 5.3-1). Multiplication of the boron concentration in the soil (B_e) by the dilution factor gives a reasonable seasonal average concentration to which the plants respond. In the analyses which follow it is assumed that the distribution of rainfall and distribution of water quality parameters are independent. This assumption becomes more favorable as impoundments are constructed in the basin.

The expected changes in yield from those yields which would occur in the upper basin (East Fork) and within the Fort Peck Reservation if these crops were presently being irrigated were computed for the four crops. The changes were derived by taking the equilibrium boron concentrations calculated with irrigation waters using median scenario 3 values and entering the yield functions to estimate a present percent yield. The B_e for scenarios 4A, 8A, 28, and 29 were then computed and the rainfall dilution factors applied. These concentrations were used in the yield functions and the differences between these yields and present yields computed. The changes in yield were also estimated for the combined effects of boron, salinity, and sodicity. These results are discussed following the section on salinity and sodicity effects.

The present yields for 1975 for alfalfa, wheat, barley, and oats due to soil boron (assuming native boron has no effect) are estimated to be 89 percent, 100 percent, 86 percent, and 75 percent of the optimum for the East Fork sub-basin and 89 percent, 100 percent, 85 percent, and 75 percent within the Fort Peck Reservation, respectively. These present yields assume no moisture stress. The projected yield reductions due to boron are less than the projected reductions due to salinity. The maximum yield reductions in the East Fork sub-basin at the 10 percent probability level of water quality for dry years due to boron were predicted as follows:

Crop	Percent Yield Reduction For Present Yield	
	Scenario 8A	Scenario 29
Alfalfa	2	0
Wheat	6	1
Barley	7	1
Oats	5	1

The maximum reductions in the Fort Peck Indian Reservation were predicted as follows:

Crop	Percent Yield Reduction From Present Yield	
	Scenario 8A	Scenario 29
Alfalfa	0	0
Wheat	1	0
Barley	1	0
Oats	2	1

Table 5.3-1

IRRIGATION REQUIREMENTS AND DILUTION FACTORS FOR ALFALFA AND SMALL GRAINS

Crop	Rainfall Probability Level					
	90%		50%		10%	
	DF*	IR+	DF	IR	DF	IR
Alfalfa	.64	18.9	.76	22.2	.81	25.4
Small grains	.66	14.1	.77	16.3	.82	17.5

*DF = Dilution Factor, dimensionless

+IR = Irrigation Requirements, inches

5.3.2.2 Other Boron Impacts

With respect to stock watering, boron is probably of little consequence. Boron fed to the dairy cow as boric acid at the rate of 16-20 g/d or 40 days had no ill effects (Water Quality Criteria, 1972). Even at 4 mg/l of boron, this represents about 220 gallons per day, or more than seven times what milk cows consume and about 21 times what beef cattle consume ("Water-use in Montana," Montana DNRC Inventory Series Report 13, 1975. A suggested limit for livestock was 5 mg/l, although this was based on the maximum concentration found in a survey of lakes and rivers and not on specific effects of boron (Water Quality Criteria, 1972). The limit was not included in the 1976 update Quality Criteria for Water. Boron concentrations at stations 1 and 3 exceed 5 mg/l for part of the year at the 50 and 90 percent probability levels for scenarios 4A and 8A. Boron concentrations exceed 5 mg/l for some months at stations 1 and 3 only with four 300 MW units without the ash decant (scenario 32). Boron concentrations at station 8 exceed 5 mg/l in February with one 300 MW unit and in four additional months with two 300 MW units at the 90 percent probability level for scenarios 4A and 8A. Concentrations at station 8 were below 5 mg/l for all scenarios without the ash lagoon decant (scenarios 28-32). Concentrations at station 12 do not exceed 5 mg/l for any scenarios.

There is no drinking water standard for boron. The highest boron concentrations without the ash input to the Cookson Reservoir at the 90 percent probability level are 4.1 mg/l with up to three 300 MW units and 8 mg/l with four 300 MW units and year 2000 level of development. With all the ash decant entering the Cookson Reservoir, the concentrations may reach 20 mg/l at station 1 at the 90 percent probability level. Concentrations of 5 to 20 g of boric acid (one-time ingestion) may cause death in adults (Stecher, P.G., 1968). The concentrations in the East Fork are considerably less than this and the concentration in the water supply would be even smaller due to adsorption as the water moved through the soil to the well and due to dilution by the Middle Fork and ground water.

5.3.3 Salinity and Sodicity

Historical TDS concentrations on the East Fork at the border range from 153 mg/l in March to 1784 mg/l in January. In general, the highest concentrations occur in the winter and lowest concentrations occur in April and May. Under Apportionment VI, the range of concentrations increases as follows:

Range of TDS, mg/l	No. of 300 MW Units	Year
260-1064	1	1975
288-1345	2	1985
330-2079	3	1985
330-2079	3	2000
381-4796	4	2000

These concentrations can be compared to predicted 1975 conditions with Cookson Reservoir but without apportionment or the power plant, which range from 243 mg/l in May to 925 mg/l in November.

Downstream stations are affected by the flow apportionment, operation of the power plant and irrigation return flows. Predicted salinity (TDS), sodicity, and sulfate concentrations are shown in Table 5.3.2. SAR (sodium adsorption ratio) is not a true conservative parameter so actual downstream values are higher than given by the model. Detailed tables showing concentrations by month and station for three probability levels are included in Appendix G.

These parmeters and sulfate can be used to classify irrigation water (Klarich, 1978) as shown below:

Water Class	SAR	SO_4 (mg/l)	Salinity as TDS (mg/l)
I	<1.0 - 4.2	<192 - 480	<700
II	1.0 - 11.6	192 - 960	350 - 2100
III	>9.0 - 11.6	>576 - 960	>2100 - 3000

Based on this classification system, the river water at stations 3, 8, and 12 would be considered class II for scenarios 28 through 32, 4A and 8A and for historical (scenario 2) and 1975 conditions (scenario 3). The water at station 1 would be class II for scenarios 2, 3, 28 through 31, 4A and 8A; class I for scenario 28 at the 10 and 50 percent probability level and class II at the 90 percent probability level; and class III for scenario 32.

5.3.3.1 Salinity and Sodicity Impacts on Crops

The effects of salinity on crops are considered to be primarily osmotic. Plants respond to the total ion content of the soil solution as well as to specific ions. In this investigation the electrical conductivity of the saturation extract (EC_{se}) has been used to determine the osmotic stress on plants due to salt buildup in the soil profile. The symptoms of salinity poisoning to crops are retarded growth as evidenced by fewer plants with smaller and fewer leaves (Rhoades, 1972). Sodium, however, can have a toxic effect and can damage soil structure reducing permeability. High concentrations of a single ion, such as sodium, also may upset the competitive uptake of other beneficial nutrients (Kamphorst and Bolt, 1976).

The sodium adsorption ratio (SAR) is the water quality index with which the sodicity hazard has been estimated. It is a measure of the availability of the monovalent sodium ion to the availability of the beneficial calcium and magnesium divalent species. The SAR values used are for the soil saturation extract as calculated in Appendix A. The exchangeable sodium percentage (ESP) has also been used as an index of sodicity (Chang and Dregne, 1955; Bains, et al., 1970; Agarwala, et al., 1964). The SAR is used in this investigation because it is consistent with Gapon's equation (Sposito and Mattigod, 1977) and the Poisson-Boltzman equation (Bower, 1961) for double layer exchange.

Table 5.3-2

SALINITY, SAR, AND SO_4 CONCENTRATIONS AT SELECTED STATIONS

Stations	Scenarios*	Salinity (TDS), mg/l		SAR		SO_4, mg/l	
		June	Sept	June	Sept	June	Sept
1	3	844	907	4.5	4.6	229	244
	4A	1099	1285	5.3	5.6	354	439
	28	946	1028	4.8	4.9	260	284
	29	1131	1268	5.2	5.4	311	348
3	3	827	950	5.0	5.7	226	268
	4A	1095	1277	5.4	5.8	336	415
	28	884	988	5.1	5.8	240	279
	29	1004	1102	5.2	5.9	266	298
8	3	918	1087	6.1	7.1	248	324
	4A	974	1189	6.0	6.6	275	367
	28	935	1087	6.1	7.1	264	321
	29	989	1133	6.2	7.2	274	329
12	3	1147	1367	8.7	9.5	242	293
	4A	1135	1364	8.7	8.8	242	306
	28	1147	1367	8.7	9.4	242	243
	29	1187	1369	8.7	10.1	261	295

Values shown give concentration which is exceeded only 10 percent of the time. Monthly tables at the 10, 50, and 90 percent probability levels are included in Appendix G.

*Scenarios are defined as follows: 3 = existing conditions with Cookson Reservoir but not power plant, 4A = 1975 development with one 300 MW unit and ash lagoon decant, 28 = 1975 development with one 300 MW unit and no ash lagoon decant, 29 = 1985 development with two 300 MW units and no ash lagoon decant.

Numerous studies have been done to determine the effects of salinity and sodicity (Table 5.3.3) including one study by Werkhoven (1964) in which he grew alfalfa and wheat on three loam soils from southeastern Saskatchewan. Several studies also investigated the effect of leaching fraction on the salinity and sodicity hazard. Additional information on the salt and sodium tolerance of these agricultural crops can be found in Biggar and Fireman (1960), Agarwala, et al. (1964), Wahhab (1961), Bernstein, et al. (1974), Hanks, et al. (1977), and Shourbagy and Wallace (1965).

Methodology for Estimating Crop Yields

From most of the literature surveyed on salinity and sodicity it is unclear whether the decrease in crop yield is a result of an increase in SAR or conductivity in the soil solution since in most cases they vary coincidentally. The two variables are related best to percent yield using the following function:

$$f(\mathrm{SAR}, \mathrm{EC})_{se} = \ln (\mathrm{SAR} \times \mathrm{EC})_{se}$$

where SAR is computed with Na^+, Ca^{2+}, Mg^{2+} expressed in meq/ℓ, EC has units of mmho/cm, and the subscript $_{se}$ stands for saturation extract measurement. The yield data from each experiment were reduced to relative yield by dividing each yield by the maximum yield for each soil type. These percent yield data were then plotted against the corresponding f $(\mathrm{SAR}, \mathrm{EC})_{se}$ value for each crop. Each crop responded similarly as shown in the plots (Appendix G). At an f $(\mathrm{SAR}, \mathrm{EC})_{se}$ value of approximately 1.5 yield reduction began to become evident and decreased approximately linearly. Below this threshold value, yields were consistently around 100 percent.

Relative yield functions were obtained from linear regression on the "declining yield" portion of the plots. The functions are as follows:

$$\text{Percent Alfalfa Yield} = 100\% \quad \text{for} \quad x < 1.7$$

and

$$= 129.81 - 17.41 (x), \; x \geq 1.7 \qquad (r = -0.71)$$

$$\text{Percent Wheat Yield} = 100\% \quad \text{for} \quad x < 0.4$$

and

$$= 105.12 - 11.75 x, \; x \geq 0.4 \qquad (r = -0.62)$$

Table 5.3-3

AVAILABLE STUDIES ON SALINITY AND SODICITY HAZARDS

Reference	Crops[+]	Soil Types	Number of Leaching Fractions Used
Bernstein and Pearson (1956)	A,W,B,O	Pachappa loam, Chino clay	1
Chang and Dregne (1955)	A	Gila clay loam	1
Chang (1961)	A	Gila loam	1
Werkhoven (1964)	A,W	6 SE Saskatchewan soil types	1
Bower, Ogata and Tucker (1968)	A	Pachappa sandy loam	4
Bower, Ogata and Tucker (1969)	A	Pachappa sandy loam	>1
Bernstein and Francois (1973)	A	Pachappa sandy loam	>1
Ingvalson, Rhoades and Page (1976)	A	Pachappa fine sandy loam	1
Ayers, Brown and Wadleigh (1952)	W,B	Pachappa fine sandy loam	1
Mehrotra and Gangwar (1964)	W,B,O	6 Indian soils	1
Asana and Kale (1965)	W	Indian soil	1
Torres and Bingham (1973)	W	sand culture	1
Elgabaly (1955)	B	resin sand culture	1
Bains, *et al*. (1970)	B	sandy loam	1
Hassan, *et al*. (1970)	B	Hobbs silt loam	1
Patel and Dastane (1971)	B	several types	4

[+] Crop types are A = alfalfa, W = wheat, B = barley, and O = oats.

Percent Barley Yield $= 100\%$ for $x < 1.5$

and

$= 126.15 - 17.22\,x,\ x \geq 1.5$

$(r = -0.75)$

Percent Oat Yield $= 100\%$ for $x < 1.8$

and

$= 153.55 - 29.38\,x,\ x \geq 1.8$

$(r = -0.95)$

where $x = \ln((\mathrm{SAR}) \cdot \mathrm{EC})_{se}$ in all the above equations.

Based on these empirical relationships it appears that oats have the highest threshold tolerance for SAR and EC of the saturation extract but are also most sensitive to increments of the two (having the highest slope). Wheat apparently has the lowest threshold tolerance and is least sensitive to incremental increases in SAR_{se} and EC_{se}. Alfalfa and barley appear to be almost equally tolerant.

The average soil properties and dilution factors were estimated as described in section 5.3.2.1 Boron Impacts. The soil chemical data (Table 5.3-4) show that the soils within the Fort Peck Reservation are more nutrient enriched. The quality of irrigation waters applied to these soils was tabulated at the 90, 50, and 10 percent probability level. The steady-state values of EC_{se} and SAR_{se} resulting from application of irrigation water to these soils for three leaching fractions (0.1, 0.2, and 0.3) were then computed as a seasonal average for April through September. These are the values of EC and SAR to which the plants would respond. The derivation of the EC_{se} values from the TDS and SAR of the irrigation water using the method of Kamphorst and Bolt (1976) is described in Appendix G.

Yield Changes

The present yields relative to optimum of alfalfa, wheat, barley, and oats due to salinity and sodicity of the soil are estimated to be 92, 79, 88, and 89 percent for the East Fork sub-basin and 66, 61, 62, and 44 percent for the Fort Peck Reservation, respectively. These yields are based on the median water quality value for scenario 3 irrigation water with a leaching fraction of 0.2 and no moisture stress. The maximum yield reductions due to salinity in the East Fork sub-basin in dry years and poor water quality conditions (90 percent probability level) are as follow:

Table 5.3 4

AVERAGE CHEMICAL DATA FOR UPPER BASIN SOILS AND SOILS WITHIN FT. PECK

Location	B*	Ca	Mg	K	Na	CEC	pH	EC_{se}	SAR_{se}
	mg/ℓ					meq/100 g	-	mmho/cm	(meq/ℓ)
Upper Basin (U.S. portion)	11.7	37.7	16.4	-	141.2	17+	7.9	1.9	4.8
Fort Peck Reservation	3.5	60.0	63.0	170.	255.	29	8.1	1.8	5.5

+Estimated value

*Boron concentrations are total boron for the upper basin and hot water soluble boron in the Fort Peck Reservation.

Crop	Percent Yield Reduction From Present Yield*	
	Scenario 8A	Scenario 29
Alfalfa	51(31)	43(23)
Wheat	34(21)	29(16)
Barley	50(30)	43(23)
Oats	86(52)	73(39)

*For 0.1(0.2) leaching fraction.

The maximum yield reductions due to salinity in the Fort Peck Reservation in dry years and poor water quality conditions (90 percent probability level) are as follows:

Crop	Percent Yield Reduction From Present Yield*	
	Scenario 8A	Scenario 29
Alfalfa	28(8)	29(9)
Wheat	19(5)	20(6)
Barley	28(8)	29(9)
Oats	44(13)	44(15)

*For 0.1(0.2) leaching fraction.

Additional irrigation water applied to the soil removes or leaches the salts built up by evaporation and thus decreases the salinity of the soil. For example, a leaching fraction of 0.1 indicates that 10 percent more water is applied than required by the crop. The yield reductions are significantly less with a leaching fraction of 0.2 instead of 0.1. The improvement in yield with a leaching fraction of 0.3 is most pronounced for the poorer irrigation water quality at the 90 percent probability level, as would be expected. The improvement with a leaching fraction of 0.3 is small for the other probability levels.

5.3.3.2 Impact on Crops of Combined Effects of Salinity, Sodicity, and Boron

The effects of boron and salinity/sodicity were considered to be additive. The yield reductions were computed for scenarios 4A, 8A, 28 and 29. Summary tables are included in Appendix G. Since the SAR values from the model are low, the yield reductions for the Fort Peck Indian Reservation could be greater.

The worst case scenarios 4A and 8A will be discussed first. For alfalfa grown in the East Fork sub-basin, yield reductions of up to 53 percent may occur with a leaching fraction of 0.1 in low rainfall years. Yield increases can occur when the leaching fraction is increased to 0.2 under median or higher rainfall and water quality conditions. In general, yield reductions within the Fort Peck Reservation for alfalfa would be less. The increased reduction due to the addition of two 300 MW units is 4 to 10 percent in the East Fork sub-basin and negligible in the Fort Peck Reservation. Yield reductions of up to 40 percent are possible for wheat for a leaching fraction of 0.1 and generally seem greater than for alfalfa in the East Fork. Within the Fort Peck Reservation yield reductions for wheat are estimated to be up to 20 percent. Barley yield reductions are estimated to be up to 56 percent in the East Fork. Yield reductions within the Fort Peck Reservation are about the same as for alfalfa (29 percent).

Oats were shown to be the most sensitive crop from the salinity standpoint and with low rainfall and leaching fraction of 0.1 no crop would be produced if irrigated. Severe yield reductions of up to 45 percent would also be realized in the Fort Peck Reservation.

The yield decreases for scenarios 28 and 29 without the ash decant are less than for scenarios 4A and 8A. The maximum yield decreases in low rainfall years with a leaching fraction of 0.1 are as follow:

Crop	Percent Yield Reduction From Present Yield	
	East Fork	Fort Peck Reservation
Alfalfa	43	29
Wheat	30	20
Barley	44	29
Oats	74	45

These yield reductions are 20 to 30 percent less than for scenarios 4A and 8A. Yield increases may occur at high leaching fractions in years with at least the median rainfall for all crops. Oats could be irrigated although the yields would be low during years with poor water quality and a low leaching fraction.

5.3.3.3 Other Salinity Impacts

The IJC has proposed interim water quality objectives during March through October on the East Fork at the International Boundary (IJC, 1981). The recommendations are a maximum long-term flow-weighted average concentration of 1000 mg/l and a maximum flow-weighted concentration of 1500 mg/l for any three consecutive months. For the period after construction of the reservoir but without an apportionment or an operating power plant, TDS concentrations on the East Fork at the border from March 1975 through September 1978 ranged from 97 mg/l in March 1976 to 1480 mg/l in July (USGS data). Thus, these objectives would have been met. The model results indicate that the objectives could be met with Apportionment VI and up to two 300 MW units operating. With three units operating, TDS concentrations during drought years could exceed the 1500 mg/l criteria during three consecutive months. With four units operating, both the proposed criteria could be exceeded.

The high TDS concentrations may result in water at Scobey's municipal wells having concentrations above the EPA secondary drinking water standard of 500 mg/l (EPA, 1977). TDS concentrations exceed this limit for drinking water of 500 mg/l at stations 3 and 7 for all scenarios including historical conditions during all but a few winter months at the 10 percent probability level. Waters containing in excess of about 1300 mg/l TDS may be considered unacceptable by consumers. TDS concentrations above 1300 mg/l were predicted at station 3 for scenarios 29 through 32 and 8A at the 90 percent probability level. Diluting flow would be available from groundwater and from the Middle Fork in the spring and winter and at other times only in high rainfall years.

TDS concentrations above 3000 mg/l can cause effects in poultry. Concentrations exceed 3000 mg/l for scenario 32 in the winter at the 90 percent probability level at stations 1 and 3 but not for any other scenarios. All concentrations are below 5000 mg/l so would be suitable for livestock.

5.3.4 Sulfate (SO_4)

Secondary Drinking Water Standards (EPA, 1977) for SO_4 have been established at 250 mg/l. This is due to the fact that SO_4, when present in potable water in high concentrations or when in moderate concentrations and consumed by individuals unaccustomed to it, may have a laxative effect.

The water quality modeling results indicate that the SO_4 standard for drinking water is exceeded on an historical basis about 10 percent of the time during low-flow months (August-March) in the Lower East Fork near Scobey (Appendix Table G.2-3). Under Apportionment VI and with up to two 300 MW units in operation (1985), the standard would be exceeded 10 percent of the time every month. The maximum 90 percentile concentration under scenario 29 is 383 mg/l (during January) and 386 mg/l for scenario 2. The standard would be exceeded 50 percent of the time for scenarios 4A and 8A with a maximum 90 percent concentration of 665 mg/l for station 3 and 280 mg/l for station 7.

Operation of three or four units at 1985 or 2000 level of development would result in significant SO_4 concentrations. With four units (scenario 32) the drinking water standard would be exceeded at least 50 percent of the time during low-flow months. Maximum concentrations occurring at a frequency of 10 percent during low-flow months would exceed 800 mg/l.

Sulfate is also an important water quality constituent in relation to agricultural uses. Sulfate concentrations are an indication of potential salinity and may also be directly toxic to plants at concentrations greater than 500 mg/l. Sulfate ion concentrations at all stations generally increase both with increasing numbers of power plants on the reservoir and with increasing irrigation development. Concentrations tend to remain relatively constant as the irrigation season progresses in the East Fork whereas they tend to increase during the summer at the lower stations on the main stem of the Poplar. The only time when levels are unacceptable in the system are at the International Boundary in March under scenarios 30 through 32 and 8A at the 90 percent probability level. Therefore, sulfate ion concentration does not appear to be a crucial factor to consider with regard to suitability of waters for irrigation.

5.3.5 Mitigative Measures to Reduce Impacts of Saline Irrigation Waters

Due to the high potential for increased salinity of Poplar River waters following power plant development and associated apportionment agreements between the U.S. and Canada, it is appropriate to discuss potential mitigative measures. High salinity water used for irrigation may have two potential impacts:

- Direct salinity damage to irrigated crops.
- Downstream effects on a variety of water uses due to highly saline irrigation return flows.

In arid regions, when rainfall is less than 20 inches/year, little leaching occurs and salts tend to build up in the soil profile. High soluble salt concentrations can have detrimental effects on plants due to plasmolysis; that is, water tends to move out of plant tissues into the soil until plant cells collapse. Irrigation with saline waters can aggravate this situation.

Irrigation appears to be the practice which will dominate agricultural water consumptive use in the Poplar River Basin in the future. Irrigation can be extremely beneficial to the economy of the basin. However, if improperly managed, it can have detrimental effects. Overirrigating can cause mineral salts to be leached from the soils and introduced into shallow ground water aquifers which recharge the river, impairing water quality downstream. Downstream impacts include not only problems of saline waters for municipalities and stock watering operations, but also for other irrigators who, in turn, must irrigate their crops with more saline waters. Irrigating with a very low leaching fraction can cause salts to build up in the soil to toxic levels. Potential mitigative measures for each of the aforementioned impacts of saline water irrigation are discussed in the following sections.

5.3.5.1 Mitigative Practices for Salinity Control in Soils

There are three methods by which salinity in soils can be controlled. These are leaching with irrigation water, conversion of alkali carbonates into sulfates and control of evapotranspiration (Brady, 1974).

Leaching of salts from the soil profile should be done with irrigation waters having small amounts of exchangeable sodium. Removal of neutral salts may increase alkalinity because of increased sodium saturation and consequent increases in hydroxyl ion concentrations. This can be avoided by treating with gypsum or sulfur which will convert sodium carbonates or bicarbonates to sodium sulfate. Sodium sulfate can be easily leached from the profile. Application of sulfur to soils creates sulfuric acid which not only converts the carbonates to more soluble salts but reduces alkalinity as well.

Although steps are taken to reduce salinity in soils, the fact remains that some crops are more tolerant to elevated levels of salinity than others. Therefore, good management of saline soils requires selection of the proper crop. Table 5.3-5 shows crops that could conceivably be grown in the Poplar basin and their relative tolerance to salinity.

Tolerance to salinity is governed by many factors. Stage of growth and rooting habits are among these factors. Plants also respond differently to similar concentrations of different salts. Selection of plant species must be done primarily based on experience but with proper salinity management a wider variety of crops can be grown with satisfactory yields.

5.3.5.2 Mitigative Irrigation Practices for Salinity Control in Return Flows

Surface return flows or tail waters are very rarely treated and sub-surface return flows are virtually impossible to treat. Therefore, practices are normally adopted to mitigate the water impacts of increased irrigation water utilization in the field. These measures can be broken down into two basic groups--either water conveyance or on-farm management.

Improving Conveyance

Seepage out of irrigation diversion ditches is a major source of salinity resulting from irrigation. Conveyance losses decrease the efficiency of the irrigation system and cause the gross diversion requirements to increase. Conveyance efficiency can be increased by lining channels with a concrete slip or a plastic membrane. This prevents losses to groundwater via leaching beneath ditches. The next level practice would be conduits of buried PVC pipe which would preclude both seepage and evaporative losses. Friction in pipe runs generally requires that pumps be installed to provide the necessary flows. Metering of turn-out volumes can also reduce over-irrigating and subsequent impairment of return flow quality.

On-Farm Management Practices

On-farm management practices for reducing salinity in return waters can be broken down into two categories:

- Lining of on-farm conveyances
- Altering irrigation practices or switching to a more effective system

Table 5.3-5

RELATIVE TOLERANCES OF VARIOUS CROPS AND FORAGE SPECIES TO SALINITY ARRANGED ACCORDING TO DECREASING TOLERANCES WITHIN GROUPS; MODIFIED FROM ALLISON (1964) AND FROM HEM (1970).*

Tolerant------- to -------Semi-Tolerant and Moderately Tolerant------- to ------Sensitive

		Field, Truck, and Fruit Crops		
Barley	Garden Beets	Tomato	Bell Pepper	Field Beans
Sugar Beets	Kale	Broccoli	Carrot	Radish
	Asparagus	Cabbage	Onion	Green Beans
	Spinach	Cauliflower	Peas	Apple
	Rye	Lettuce	Squash	Boysenberries
	Wheat	Sweet Corn	Cucumber	Blackberries
	Oats	Potato		Raspberries
	Corn			Strawberries
	Flax			
	Sunflower			
		Forage Species		
Saltgrass		Sweetclover	Oats (hay)	White dutch clover
Bermudagrass		Perennial ryegrass	Orchardgrass	Meadow foxtail
Tall wheatgrass		Mountain brome	Blue grama	Alsike clover
Rhodesgrass		Harding grass	Meadow fescue	Red clover
Canada wildrye		Beardless wildrye	Reed canary	Ladino clover
Western wheatgrass		Strawberry clover	Big trefoil	Burnet
Tall fescue		Dallisgrass	Smooth brome	
Barley (hay)		Sudangrass	Tall meadow oatgrass	
Birdsfoot trefoil		Hubam clover	Milkvetch	
		Alfalfa	Sourclover	
		Rye (hay)		
		Wheat (hay)		

*After Klarich, 1978

the first of which has been discussed in the previous section.

Salinity pickup by irrigation waters cannot be wholly eliminated because of the need to provide a flow of water through the root zone which ameliorates the concentrating effects due to evapotranspiration. Due to non-homogeneity of the soils, water is normally applied such that the species with the highest water-holding capacity will receive the required leaching fraction resulting in over-irrigation on the remainder of the field. Obviously, one method of reducing salt pickup is to increase the efficiency of water applications. Applicable methods are briefly discussed in increasing order of efficiency.

Spreader Dike or Level Border Irrigation

Spreader irrigation systems are well suited for alfalfa and small grains and consequently have been popular in the Poplar River Basin. With level border irrigation, water is turned onto level plots to form basins from which infiltration takes place. There is no surface return flow from these systems.

The average U.S. efficiency for level border irrigation is about 59 percent (Evans, et al., 1978). Efficiencies of 70 to 75 percent have been realized with good management. This requires level fields so that water will not collect disproportionately in certain areas, insuring uniform infiltration. The amount of water turned into the system should be regulated so that over-topping of dikes and excessive deep seepage does not occur.

Flood or Furrow Irrigation

Flood irrigation involves the application of water into small furrows which traverse the field slope. To apply water efficiently, the inlet discharge and duration of flow must be a function of soil properties such as water-holding capacity and infiltration rates, field slope and furrow geometry. Ideally, the flow rate and duration can be adjusted so that the quantity of water that infiltrates all along the furrow is uniform. Differences in soil characteristics will cause over-irrigation in instances where the soil with the least water-holding capacity is properly irrigated. In these systems tail-water or surface return flow is the result of over-irrigation in addition to augmented seepage losses. According to the soil type, either salt pickup from excessive infiltration or sediment erosion from surface return can be the major consideration.

There are several ways by which flood irrigation can be made more efficient. The first of which is closely monitored irrigation scheduling.

A second method is called cut-back furrow or flood irrigation. The inlet must be automated such that a large "wetting" flow is admitted at the head of the furrow and then the flow is decreased or cut back to a smaller flow to finish the irrigation. By using this method tailwater flows are reduced substantially. Both efficiency and excessive percolation losses leading to salt build-up of return flows are decreased.

Finally, an alternative whereby tailwater flows could be eliminated completely is through collecting and repumping of surface runoff waters. This represents an increase in cost over the cut-back alternative.

For flood, as with spreader-dike irrigation, land grading will aid the application uniformity and therefore increase water use efficiency and salinity control capability.

Sprinkler Irrigation

Irrigation by sprinklers is desirable because of the high uniformity of application. Excessive losses due to percolation and surface runoff can be effectively minimized. This method has the additional advantage that the leaching fraction may be reduced without serious crop effects. Evans, et al., (1978) reported that studies at the U.S. Salinity Laboratory have shown that the leaching fraction can be reduced by one-fourth of present values without a reduction in alfalfa yields. Because percolation losses are minimized, nutrient losses are reduced also. In fact, some water soluble fertilizers can be applied directly through the sprinkler system.

With systems yielding increasing application efficiency, the water quality of the water used for irrigation should be better. Particulates in water flowing through sprinkler systems can cause corrosion and wear on piping and valves, and can clog sprinkler nozzles, whereas this causes no problems in surface systems. Water of poor quality can leave deposits on plants and cause burning which may lower the aesthetic quality of the fruit or cause physiological effects. Deposition of fine particles on the soil surface can also cause crusting which may reduce infiltration rates and promote runoff from both natural rainfall and sprinkler applications.

In addition to better water quality requirements, sprinkler systems involve a higher capital outlay and higher operating costs, if pumping is required. Labor costs usually are substantially less and can be made even more so because of the compatibility of sprinkler irrigation and automation.

5.3.5.3 Source Control of Salinity

Increased TDS concentrations can also be potentially controlled at the source. There are two main alternatives:

- Control of Fife Lake overflows. The relatively high salinity of Fife Lake overflows may exert considerable influence on reservoir TDS concentrations. A potential control measure would involve diking to control releases at Fife Lake during periods of maximum potential for downstream impact.
- Prevention of discharge or treatment of ash lagoon decant, ash lagoon seepage and mine dewatering effluent.

As discussed in Section 5.3.1 the routing of the ash decant to the Cookson Reservoir increases the TDS and boron concentrations in the upper East Fork significantly. Saskatchewan Power Corporation will recycle the ash decant and minimize seepage from the ash lagoons (IJC, 1981). The proposed plan would be to compact 300 mm of glacial till to limit the seepage to less than 2 l/sec of which an estimated 0.2 l/sec would enter the reservoir. The remainder (approximately 1.4 l/sec) enters the Empress Gravel aquifer and flows toward the East Fork. Dilution of approximately 10:1 would occur from underflow from Cookson Reservoir and recharge from the glacial till based on ground water modeling by SPC. The estimated boron concentrations with two 300 MW units in the upper East Fork would be a maximum of 7.3 mg/l when ground water mounding is included but attenuation in the soil is not considered (Saskmont Engineering, 1979). With attenuation the boron concentration would decrease to background levels (approximately 1.2 mg/l) in the East Fork. The latter concentrations are about 50 percent of the values for scenario 8A. Thus, the impacts on crops of scenarios 4A and 8A represent a "worst case". With effective control of the ash lagoon seepage, the concentrations could be reduced nearly to the values for scenarios 28 and 29.

5.4 SOCIOECONOMIC IMPACTS OF POWER PLANT CONSTRUCTION

5.4.1 Introduction

This section describes the socioeconomic impacts that may occur in the Poplar River Basin as a result of the construction of a series of coal-fired plants by Saskatchewan Power north of the U.S.-Canadian border. As in previous sections, the impact area for this portion of the study will be in Daniels and Roosevelt counties. The potential economic impacts that can occur during the construction phase are expenditures on materials for the plant itself, and expenditures made by the construction workers in the local area for goods and services during their stay. Both of these sources of impacts are examined, and an estimate is made of the amount of money spent annually in Daniels and Roosevelt counties due to the construction project.

Impacts on cultural and historic places are not likely because population changes are not expected as a result of the project. Furthermore, there is no possibility of flooding on any cultural or historic properties.

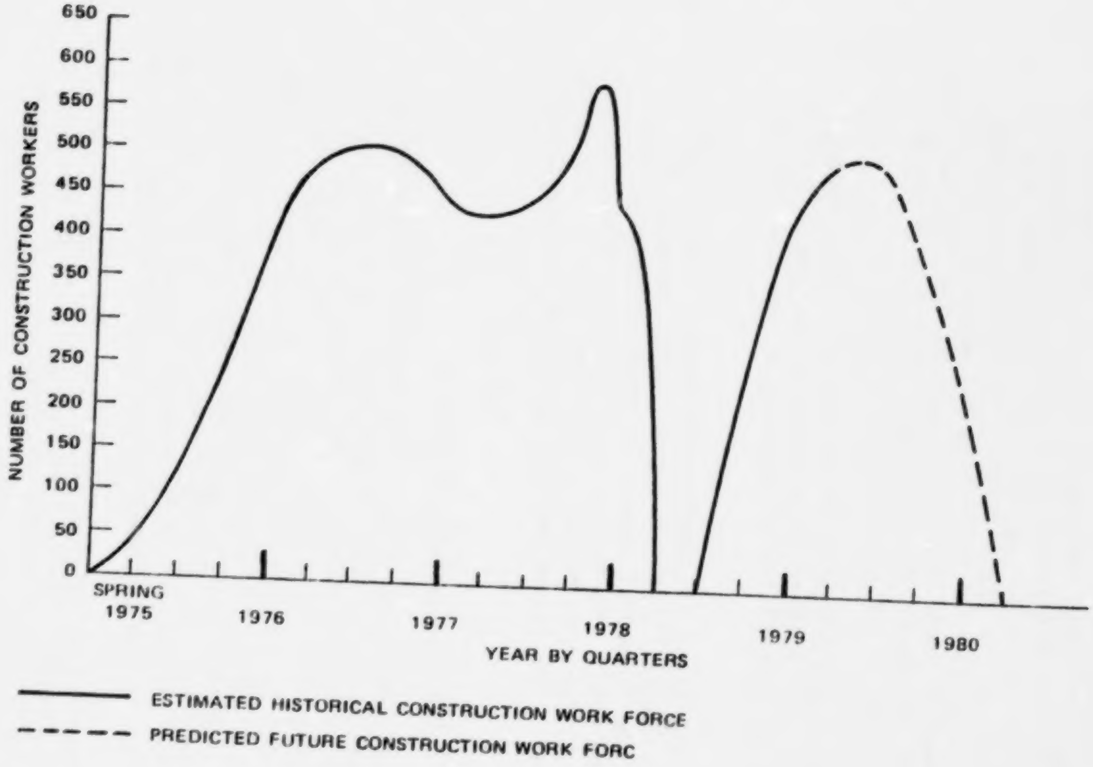
Construction of the first of Saskatchewan Power's coal-fired plants near Coronach, Canada, began in August, 1975. Work on the second unit began in the summer of 1980. The site is roughly five miles southeast of the small town of Coronach, which is about seven miles north of the U.S.-Canadian border. The first unit is continuing the conversion to coal. The second unit is scheduled for completion in 1983.

5.4.2 Description of the Construction Work Force

The work force at the Poplar River Plant consists of workers from various union contractors. The size of the construction crew has ranged from about 50 at the beginning of the project to a peak of approximately 600 workers in October, 1978. Figure 5.4-1 shows the fluctuation in the work force over the course of the project. In general, the crew averaged about 450 to 500 workers during the major portion of the construction, decreasing in the winter months when no outside work could be done, and gaining strength during the rest of the year. Between May and August, 1978, however, a strike at the plant reduced the work force to almost zero (Cairnes, personal communication).

Most of the construction force lives in the construction camp built on the site of the first unit. The camp consists of housing, a dining hall, and a recreational center providing workers with a gym, movies, television, pool table, and other types of entertainment. Workers who brought their families to the area cannot live in the camp and live instead in Coronach and other small Canadian towns in the plant's vicinity (Mathew, personal communication).

No workers live across the border in the U.S. because of the restrictions on the hours that the border is open. Traffic can only move across the border on Highway 13 between 9 A.M. and 6 P.M. Therefore, there have been no direct impacts of plant construction on U.S. employment rates.



Source: SRI International estimate using data from Ken Cairnes, telephone conversation, May 1979

Figure 5.4-1 ESTIMATED CONSTRUCTION WORK FORCE PROFILE, SASKATCHEWAN POWER PLANT UNIT 1, 1975 THROUGH 1980

5.4.3 Economic Impacts from the Plant

No spending on plant materials and equipment has taken place in Daniels or Roosevelt counties. Saskatchewan Power representative, Wayne Nordquiest, estimated that approximately $50 million of the $190 million total construction costs of Unit 1 were spent on parts and machinery in the U.S.; however, none of this money went to companies in Daniels and Roosevelt counties. Instead, the $50 million was spent on specialized pieces of equipment that were purchased outside these counties.

5.4.4 Economic Impacts from the Construction Workers

Interviews with plant representatives and others indicate that the construction workers have been purchasing many goods and services in the U.S. (Bowler, Kenny, and Cairnes, personal communications). In spite of custom charges, many goods are less expensive in Scobey and Plentywood. In addition, Coronach is a small town (population of 379 in 1971), so the workers find a greater selection of goods and less wait for services in the larger nearby towns of Scobey and Plentywood (populations of 2,041 and 3,126, respectively, in 1970).

Expenditures by Canadian workers could not be measured directly. Therefore, no precise estimate of the amount of money spent by construction workers in Daniels and Roosevelt counties is available. A rough estimate, however, can be made, and the impact that these expenditures are having on the counties can be estimated by examining county personal income and retail sales data. The supervisor of one construction crew estimated that his workers spend approximately $100 per week when they spend the weekend in a nearby U.S. town. Of this, about $70 is spent on a hotel room and entertainment, and the remaining $30 is spent on food, clothing, and miscellaneous goods and services (Sooley, personal communication). Sooley further estimated that approximately 15 percent of the construction crews went to the U.S. on any given weekend. As a basis of estimating impact, it is assumed that a maximum of 10 percent of the workers go to Scobey, and the remaining 5 percent go to towns such as Plentywood and Glasgow in nearby counties.

Because of the uncertainty involved, both an upper and lower limit for possible impacts is discussed. Using the above assumptions and estimates, the range of expenditures the construction workers would make in one year in Daniels County would be between $200,000 and $300,000. This figure assumes a construction work force of 450 to 500. It is estimated that Roosevelt County receives no expenditures from the construction workers because the largest town in the county, Wolf Point, is about 75 miles from the construction camp.

As indicated in Table 5.4-1, personal income fluctuates sharply from year to year in both counties, because of large yearly variations in agricultural harvests and crop prices. The percentage change in nonfarm income also fluctuates greatly, though not as much as farm income.

Table 5.4-1

TOTAL PERSONAL FARM AND NONFARM INCOME DANIELS AND ROOSEVELT COUNTIES 1972-1977

	Total Labor and Proprietors' Income (thousands of 1975 dollars)						Percentage Annual Change in Nonfarm Income	
	Daniels			Roosevelt				
Year	Total	Farm	Nonfarm	Total	Farm	Nonfarm	Daniels	Roosevelt
1972	$18,737	$12,740	$5,997	$41,138	$15,292	$25,846		
1973	28,407	21,802	6,605	59,559	32,326	27,233	10.1%	5.4%
1974	18,360	11,658	6,702	38,122	11,763	26,359	1.5	-3.2
1975	19,836	12,671	7,165	42,940	15,166	27,774	6.9	5.4
1976	17,446	10,051	7,395	38,707	10,561	28,146	3.2	1.3
1977	13,591	6,209	7,382	31,248	1,011	30,237	-0.2	7.4

Source: Montana Department of Community Affairs, 1978, Division of Research and Information Systems, "County Profiles," unpublished. Adjusted to constant dollars.

Table 5.4-2 shows a similar picture for retail sales. Sales vary considerably from one year to the next. The large decline in sales between 1973 and 1974 in Daniels County is probably related to the large decline in income. Farm income decreased dramatically in Roosevelt County between 1976 and 1977 due to a substantial decline in prices received by farmers for spring wheat. Neither table shows a clear increase in income or sales that might be attributable to construction worker expenditures.

5.4.5 Secondary Impacts

Construction workers spend a portion of their wages for goods and services in Daniels County. The recipients of those payments treat them as additional income and likewise spend some. Therefore, the initial expenditure is actually respent a number of times throughout the economy, generating secondary income, which is a multiple of the initial injection of funds. Daniels County does not receive all secondary impacts. These impacts are allocated to counties throughout the local and regional trading area based on the following method.

Multipliers are calculated by the Bureau of Economic Analysis (BEA) for 53 industrial sectors in each of the 173 BEA economic areas of the U.S. Daniels and Roosevelt counties are in BEA area number 93. Industrial sector number 54 (Trade) was chosen for these counties, which has a multiplier of 1.85 for Daniels and Roosevelt counties, according to the U.S. Bureau of the Census (January, 1977).

Simply applying the multiplier to the change in expenditures would not accurately represent the impact, however, because of the interdependence between the nearby counties. Spillover effects between Daniels County, the area of direct impact, and other counties occur, which can be calculated using a procedure developed by Chalmers, et al.,(1977). In this study, they noted a hierarchical relationship between different kinds of counties. For example, certain counties, designated level-3 counties, appear to serve as central market areas for groups of other counties (level-2). Level-2 counties, in turn, support groups of still lower-level counties and receive spillover effects from them. Following Chalmers' ranking scheme, we assigned each county in the BEA area a rank of 1, 2, or 3.

As in Chalmers, all level-1 counties in BEA area 93 are allocated 12 percent of the indirect impacts resulting from the direct expenditure of $200,000 to $300,000. The 12 percent is then distributed to individual level 1 counties within the BEA region by the ratio of the population of the level-1 county to the total population of all level-1 counties in the BEA region.

Table 5.4-2

TOTAL RETAIL SALES DANIELS AND ROOSEVELT COUNTIES 1973-1977

	Total Retail Sales (thousands of 1975 dollars)		Percentage Annual Change	
Year	Daniels	Roosevelt	Daniels	Roosevelt
1973	$7,379	$23,864		
1974	3,748	23,852	-49.2%	-0.1%
1975	3,407	21,681	- 9.1	-9.1
1976	3,425	20,853	0.5	-3.8
1977	3,552	20,291	3.7	-2.7

Source: Sales and Marketing Management Magazine, Survey of Buying Power (1974-1978) and adjusted to constant dollars.

Using this methodology, secondary impacts can be estimated as follows:

	Low	High
Direct Expenditures Multiplier 1.85	$200,000	$300,000
Total Impacts	370,000	555,000
Secondary Impacts	170,000	255,000
Daniels Co.	16,000	24,000
Roosevelt Co.	53,000	79,000
Other counties	101,000	152,000

Roosevelt County, although it receives no direct impacts, receives secondary impacts of about $53,000 to $79,000 annually--a larger share than Daniels County because of wholesale and retail purchases generated by activity in Daniels County. This procedure may tend to overestimate the secondary impacts in Roosevelt County since Wolf Point is so far from Scobey. Because of limited wholesale facilities in Daniels and Roosevelt Counties, much of the secondary impact occurs in places such as Glasgow and Glendive, Montana; and Minot, North Dakota. In summary, direct and secondary impacts combined in Daniels County in 1975 totaled about $216,000 to $324,000, or 6.3 percent to 9.5 percent of retail sales. The total impact of $53,000 to $79,000 represents 0.2 percent to 0.4 percent of retail sales in Roosevelt County. Both counties had declines in sales of about 9 percent between 1974 and 1975. Daniels County, however, recovered in the following two years, whereas Roosevelt County continued to decline by about 3 percent to 4 percent annually.

Expenditure changes can also be related to personal income. Using the fact that income is roughly 0.3 percent of gross output, or sales, it can be calculated that the total increase in sales resulting from the construction workers amounts to about 0.3 percent to 0.5 percent of personal income in Daniels County in 1975, and 0.9 percent to 1.4 percent of nonfarm personal income for the same period. In Roosevelt County, the increase in sales represents an increase of less than 0.1 percent for both total and nonfarm personal income in 1975.

Although the revenue from the construction workers represents a benefit, this impact is far less significant to Daniels County than the impact of changes in prices received by farmers. The effect of wheat prices greatly overshadows any possible impact that construction workers could have in this area.

5.5 SOCIOECONOMIC IMPACTS OF APPORTIONMENT

5.5.1 Introduction

The apportionment of water from the Poplar River will affect the amount of land irrigated in Daniels and Roosevelt counties and the quality of the irrigation water. This section estimates economic conditions, from 1975 to 2000, and the impacts of Apportionment VI on farm income and total income in Daniels and Roosevelt counties.

5.5.2 Future Conditions

The Poplar River Basin is a sparsely populated, rural area that is unlikely to change significantly before 2000*. The only significant development expected to take place over the next 25 years is the construction of a potash plant, and the likely population influx associated with the plant is included in the projections. Significant deposits of lignite occur in the region of the Fort Peck Indian Reservation. Unpublished data indicate that, under reasonable projections of future coal demand, it is unlikely that these deposits would be developed and mined before 2025. Compared with other coal resources, the lignite is economically and geologically unattractive (Yabroff and Dickson, 1979). However, federal policies promoting coal development to reduce dependence on imported petroleum could overcome the market constraints. It is possible that some development could occur in the vicinity of McCone County by 1990 although there is substantial local resistance to large energy developments in McCone County (Parfit, 1980). Two coal-related projects investigating sites near Circle, Montana are the Basin Electric Power Cooperative and the Circle West Project. The planned development by Basin Electric would be two 500 MWe coal-fired power plants with the first unit to begin operation in 1988. Basin expects to select a site in early 1980 (personal communication - EPA, 1980). Sites being considered for the Circle West Project are in McCone County.

Table 5.5-1 shows population and employment projections for 1980, 1985, and 2000. The ratio of employment to population for the period 1971 to 1977 was used in estimating future employment, based on the population projections. Because no discernible trend was identified, future employment was estimated as the average of the employment-to-population ratio for 1971 to 1977. The average ratios for Daniels and Roosevelt counties, respectively, were 0.47 and 0.42.

---

*The projections presented here are based on population projections made by the Montana Department of Community Affairs.

Table 5.5-1

PROJECTED POPULATION AND EMPLOYMENT
DANIELS AND ROOSEVELT COUNTIES -- 1980, 1985 and 2000

Year	Population[1]		Employment[2]	
	Daniels	Roosevelt	Daniels	Roosevelt
1975	3,100	10,300	1,480	4,430
1980	3,100	10,700	1,500	4,500
1985	2,900	10,900	1,400	4,600
2000	3,400	11,500	1,600	4,800

Sources:

1. Montana Department of Community Affairs, Research and Information Systems Division, "Montana Population Projections, 1980-2000) (July, 1978)
2. SRI estimate

Future income levels in Daniels and Roosevelt counties were estimated as the sum of wage and salary income, proprietors' income, property income, and net transfer payments. Wage and salary income was projected using projections of future wage and salary employment and 1975 wage levels. Income of nonfarm proprietors was based on the number of proprietors times the average proprietors' income for 1975.

Projecting the income of farm proprietors was complicated by having to account for additional income because of the increases in irrigated lands. Based on data of the USDA Cooperative Extension Service, conversion of existing dryland acreage to irrigated acreage was estimated to increase net incomes by $40 to $50/acre (Luft, 1979; Luft and Griffith, 1978). To be conservative and to account for possible yield and technological changes over the next 20 years, $50/irrigated acre was used to project the additional net agricultural income expected in the two counties.

The change in irrigated acreage for 1985 and 2000 is taken as the difference between irrigated acreage in the Poplar River Basin in 1975 and the desired irrigated acreages for 1985 and 2000. The projections for 1985 and 2000 are based on the completion of two proposed reservoirs on the Poplar within the Fort Peck Indian Reservation. The combined storage capacity of the reservoirs is approximately 152,400 ac-ft. It was assumed that irrigated land would be converted from existing unirrigated cropland. Because most cropland in Daniels County is within the Poplar River Basin, no other factors are likely to affect agricultural income. In Roosevelt County it was assumed that conditions outside the Poplar River Basin would remain constant. This assumption will tend to overestimate impacts because the projected conditions in Roosevelt County do not allow for additional irrigation with other sources of water or conversion of pasture and range to cropland.

Other sources of income, rent, interest, and net transfer payments were estimated from their historical relationship to the total of wage, salary, and proprietors' income. The results are summarized below in millions of 1975 dollars.

		Farm Proprietors' Income	Total Personal Income
Daniels County:	1975	$11.9	$25.5
	1985	12.0	24.7
	2000	12.1	26.8
Roosevelt County:	1975	13.6	55.6
	1985	14.1	56.2
	2000	14.6	59.2

In constant dollars, the projected gains are quite modest in Daniels County. Income of farm proprietors is projected to increase by only 1.7 percent between 1975 and 2000 and total personal income by 5.1 percent. In Roosevelt County, the gains are somewhat larger, but hardly robust: 7.4 percent for income of farm proprietors and 6.5 percent for total personal income.

These projections reflect the historical experience of agricultural income in the region. The changes in income result from changing commodity prices--especially wheat. Real growth over the long term has been slight. The outlook for the future is for continued fluctuations but for no dramatic increases.

5.5.3 Impacts on Income

The impacts of the apportionment scheme on Montana agriculture in large part depend on the amount of land that is developed for irrigation. Projections of irrigated acreage (IJC, 1979) Appendix D, that are desired by Montana interests are used as the maximum acreage which would be irrigated. The amount of new irrigated land that is likely under the apportionment will depend on the farmers' perceptions of the risks and returns involved.

Installation of a sprinkler irrigation system requires a capital investment of between $160/acre for a hand-move system and $340/acre for a circular self-propelled system (Luft, 1979). Side-roll wheel-move systems can be installed for $250 to $270/acre (Luft, 1979). Analysis of the side-roll wheel-move systems indicates that additional income of $46/acre is possible with irrigated alfalfa. Conversion of dryland wheat to irrigated wheat would result in additional income of $42.60/acre (Luft, No Date Given).

Additional income from investments in irrigation systems were estimated using data from the Cooperative Extension Service (Luft, no date given). For wheat at $2.90 per bushel the comparison of dry farming and irrigated operations is as follows:

	Dry	Irrigated
Yield (bu/ac)	30	75
Revenue (per/ac)	$87.00	$217.50
Costs		
Operating	51.15	108.64
Fixed	25.00	56.36
Total	$76.15	$165.00
Net income	$10.85	$ 52.50

Therefore, the dividend from irrigated wheat is approximately $42 per acre. A similar analysis reveals additional income of approximately $46/acre is possible by converting to irrigated alfalfa.

Side-roll irrigation systems are used as the basis for calculating impacts because they provide a convenient middle ground between the extremes of hand-move and center-pivot systems. Buying an irrigation system requires that the farm operator assume the risk of no return on his investment in a dry year. He must, therefore, be convinced that over the long run his investment will be profitable. That is, his returns in years with sufficient water must exceed carrying costs in dry years. The additional annual fixed costs of a side-roll irrigation system are approximately $35/acre. If, as discussed above, the additional income from irrigated wheat is $42/acre, a farmer could invest in an irrigation system based on the mean flows from the Poplar River. In years when flows are less than the mean, fixed costs could be covered as long as yields do not drop more than 16 percent. However, a definite risk of bankruptcy is encountered if several dry years occur consecutively. The risks with irrigated alfalfa are slightly less, allowing on the average a margin of $11/acre over annual fixed costs which is equivalent to 24 percent of average yields.

Based on the foregoing, it is assumed that farmers in the Poplar River Basin will install irrigation systems on acreage irrigable with the mean flows expected under the apportionment. This implies making use of the acreage irrigable with the mean flows for June (i.e. 16,288 acres in 1985 which is the maximum projected acreage). Moreover, it assumes that farmers can recover their investment before the fourth 300 MW unit is completed, causing mean flows for June to drop so that only 13,123 acres can be irrigated in 2000.

The preceding line of reasoning presents a plausible scenario for estimating impacts. An investment of approximately $3.0 million in irrigation systems would be required for the more than 10,000 acres in the Poplar River Basin. Given the region's long history of dryland farming, this constitutes a large, risky investment. The cautious farmer may wait to ascertain how the apportionment affects flows before he decides to make such an investment. However, in estimating impacts, the assumptions above provide a conservative approach.

The apportionment will cause a change in the irrigable acreage in Daniels and Roosevelt counties (Table F-1 in Appendix F) and a change in yields on irrigated lands because of lowered water quality. The income loss caused by the change in acreage is estimated as the difference between net income for irrigated crops and net income for dryland farming of the same crop. For the impact calculations this difference is estimated as $50/acre as explained previously. This is higher than the increases in net income estimated by Luft for alfalfa and wheat; however, it does allow for the possibility of higher wheat and alfalfa prices in the future.

The increase in net income for irrigated crops is assumed to be earned only when irrigation is possible throughout the growing season. Therefore, the change in irrigable acreage is calculated using irrigable acres for mean flows in August. The irrigable acres shown in Table F-1 in Appendix F are based on water requirements and losses. In practice, additional water may be applied to leach salts from the soils. It is assumed that 20 percent more water than is needed for plant growth will be used for leaching. Table 5.5-2 shows the changes in irrigable acres and income due to apportionment.

Income changes due to water quality are shown in Table 5.5-3 under median water quality and rainfall conditions. Further loss of income could occur in dry years when less water is available for leaching. Yield decreases up to 14 percent would be predicted if the leaching fraction decreased to 0.1 in Roosevelt resulting in an estimated decrease in income of $15,700 in 1975 and $250,200 in 1985.

Table 5.5-3

CHANGE IN YIELD AND PER-ACRE REVENUES FOR WHEAT

Location	Scenario*	Total Yield Change+	Change in Revenue Per-Acre	Irrigated Acres Affected	Income Change
Daniels County	1975 (1 plant)	-12%	-$26	1,391	-$36,200
	1985 (2 plants)	-15%	-$33	1,520	-$50,200
Roosevelt County	1975 (1 plant)	0%	0	515	0
	1985 (2 plants)	0%	0	10,618	0

*1975 is model scenario 4A. 1985 is model scenario 8A.

+Rainfall and water quality probabilities are 50 percent; leaching fraction is 0.1.

Table 5.5-2

CHANGE IN NET FARM INCOME RESULTING FROM APPORTIONMENT ONLY

	Estimated and Projected Irrigated Acres Affected by Project	Mean Acreage Irrigable in August	Difference in Irrigated Acres	Income Change	Change as % of Farm Proprietor's Income
Daniels County					
1975	2,826	1,390	-1,436	-$71,800	-0.6%
1985	3,575	1,520	-2,056	-102,800	-0.9
2000	5,342	1,520	-3,821	-191,050	-1.6
Roosevelt County					
1975	618	618	0	0	0
1985	10,618	10,618	0	0	0
2000	17,182	3,488	-13,694	-684,700	-4.8

The change in income resulting from water quality changes depends upon the sensitivity of a crop to boron and other salts and the mix of crops planted. Of the four major crops in the area, wheat is the most tolerant and oats the least tolerant. Alfalfa and barley are intermediate in tolerance. The yield losses expected for wheat are less than those for barley under similar conditions; however, because wheat has a higher price, the income losses would be greater (on a per-acre basis) for wheat. Water quality-caused reductions in yield are worst on the East Fork.

Estimating the income changes caused by water quality changes is further complicated by the added expense of farming with water that is high in total dissolved solids. First, better management is required to maintain soil quality. Other costs arise from the need to apply leaching water and from higher maintenance costs on irrigation equipment. In addition, more fertilizer may be required to replace nutrients that are leached out.

The change in farm income will result in secondary income changes in other sectors of Daniels and Roosevelt Counties, and in nearby trading centers that serve residents and businesses in the two counties. BEA Area 93 has a multiplier of 1.629 for the field crop sector in which wheat and alfalfa fall. This is used to estimate the total changes in personal income. Then, taking into account the hierarchical relationship among counties in the BEA area, the total impacts are apportioned among counties based on the method of Chalmers, et al., 1977 (See the explanation in Section 5.4.5 on construction period impacts). Table 5.5-4 summarizes the impacts on total personal income.

Table 5.5-4

IMPACTS OF APPORTIONMENT AND WATER QUALITY ON PERSONAL INCOME IN DANIELS AND ROOSEVELT COUNTIES
(Dollar Figures are in Thousands of 1975 Dollars)

County and Year	Change in Farm Income	Change in Induced Income in County	Total Change in Personal Income	Impact as Percent of Personal Income
Daniels				
1975	$-108.0	$- 5.1	$-113.1	-0.4%
1985	-153.0	- 7.2	-160.2	-0.6%
2000	-241.0	-11.4	-252.7	-1.0%
Roosevelt				
1975	$ 0	0	0	0
1985	0	0	0	0
2000	-684.7	-32.3	-717.0	-1.2%

In both Daniels and Roosevelt counties the secondary income changes plus the change in farm income amount to approximately 1.2 percent of personal income in 2000. Approximately 50 percent of the secondary impacts may flow to Minot, North Dakota (Ward County), which is the major trading center for BEA Area 93. This would have a minimal impact amounting to less than 0.1 percent of personal income in Ward County in the year 2000. The changes estimated are far less than historical variations in personal income that arise from weather variations.

The impacts described for the apportionment are quite small when compared to total agricultural activity in Daniels and Roosevelt Counties. Therefore, the regional economy will continue with little noticeable change. However, the direct impacts will be concentrated along the Poplar River and some farmers will be severely hurt by low flows and possible saline conditions. These impacts could be offset by establishing a compensation system.

The foregoing has presented an estimate of impacts that might result from apportionment of the flow in the Poplar River; however, the analysis is influenced by many underlying assumptions. Some of the more important factors that have been included are the selling price of wheat and alfalfa, the cost of water to farmers, the value of cropland, the cost of sprinkler systems, and farm operating costs. In fact, the number of possible combinations that could be considered is unwieldy. Therefore, to indicate the upper range of possible impacts, a pessimistic approach was used. That is, it was assumed that the number of irrigated acres affected by the apportionment was equal to the total projected irrigated acreage affected by the power plant and apportionment in the Poplar River Basin. This is equivalent to cutting off all irrigation waters, leaving only dryland farming in Daniels and Roosevelt counties--a possibility in extremely dry years or if water quality were reduced to harmful levels. The impacts on dry farm income resulting from the conversion of all irrigable lands to dry land farming are shown in Table 5.5-5.

Table 5.5-5

ESTIMATED IMPACTS ON NET FARM INCOME FROM LOSS OF ALL IRRIGATED ACREAGE

County and Year	Change in Irrigated Lands (acres)	Change in Farm Proprietors' Income (thousands of 1975$)	Percent Change of Farm Proprietors' Income in Region
Daniels			
1975	- 2,825	$- 140	-1.2%
1985	- 3,575	- 180	-1.5%
2000	- 5,342	- 270	-2.2%
Roosevelt			
1975	- 618	- 30	-0.2%
1985	-10,618	- 530	-3.1%
2000	-20,618	-1,030	-7.2%
Totals			
1975	- 444	- 170	-0.7%
1985	-14,193	- 710	-2.7%
2000	-25,960	-1,300	-4.9%

The largest absolute and percentage impacts would occur in Roosevelt County where net farm income could be reduced by 7.2 percent in 2000. Within the boundaries of the Fort Peck Indian Reservation, the impacts would be much higher on a percentage basis. However, all the Indians do not own and operate farmland there. Gross value of products (crops and livestock grown on Indian lands by Indian operators is estimated to be less than $10 million. In the case of no irrigated lands, impacts on total personal income would be less than 2 percent of personal income in 2000. Spillover of secondary impacts into other regions would be negligible on a percentage basis.

The preceding discussion of impacts has presented a pessimistic situation. The actual changes in income after the apportionment may be less than indicated above under the mean flow conditions. After construction of the proposed reservoirs, more land can be irrigated in 1985 and 2000 than in 1975. The average number of irrigation applications per year has been 2.4 so that even under present flow conditions, water available in August is not adequate to irrigate the full number of acres. Thus, assuming the loss of the full dividend from irrigation is very conservative. This pessimistic projection implies that dryland farming can be practical on all acreage. If the land was damaged by salts in the irrigation water to the extent that no crops would grow, greater impacts (i.e. income loss) would result. It is unlikely that farmers would allow this to occur.

5.5.4 Other Impacts

5.5.4.1 Impacts on Investment in Land and Equipment

The apportionment could affect the values of irrigated land if water is no longer available. Conceivably, between 1985 and 2000, land values could drop as the amount of irrigable land declines. Based on current crop budgets for the region, the premium for irrigated land is between $50 and $100/acre (Griffith, et al., 1978; Shaefer, et al., 1978A and 1978B).

A related impact is the loss of the undepreciated portion of any investment in irrigation equipment. For new systems, the loss could be more than $200/acre.

5.5.4.2 Impacts on Assessed Values and Tax Revenues

The impact on tax revenues was investigated by comparing assessed values for irrigated and non-irrigated lands. Table 5.5-2 shows the difference in irrigated acres as a result of the apportionment. We assume that they will be assessed as nonirrigated cropland rather than irrigated cropland. We will use the acreage change in 2000 to estimate the maximum impact. The difference in average assessed values for irrigated and nonirrigated land in 1978 was $4.13 per acre in Daniels County and $7.13 per acre in Roosevelt County. The estimation process is as follows:

	Daniels Co.	Roosevelt Co.
Change in acreage in 2000 (acres)	3,821	13,694
Change in average value ($/ac)*	- 4.13	- 7.13
Change in assessed value ($)	-15,781	-97,638
Change in taxable value (30%)($)	- 4,734	-29,291
Tax rate ($ per $1000 of taxable value)**	194.91	176.67
Change in tax receipts ($)	- 923	-$5,175
Population year 2000	3,400	11,500
Per capita change in tax receipts ($)	- 0.27	- 0.45

*Byford (1980)
**Montana State Taxpayers' Association (1978)

The estimated changes in tax receipts in 2000 are less than $0.50 per capita in Daniels and Roosevelt Counties. The change in total assessed value would be 0.1% or less because the acreage affected is small compared to the total acres in each county.

5.5.4.3 Impacts on Population and Employment

The impacts of the apportionment on farm income and total personal income are unlikely to result in noticeable changes in population. If irrigation water is unavailable, farmers will resort to dryland farming. The trend to fewer and larger farms would not be affected by the changes estimated here. An increase in demand for seasonal farm workers is likely to occur if all the growth in irrigated lands takes place as projected. The converse would occur if the amount of irrigated land, and, therefore, crop yields are diminished. It is difficult to estimate the number of seasonal employees affected because no data exist regarding the current seasonal farm employment available. However, in Daniels and Roosevelt Counties together fewer than 300 full and part-time workers were employed in agriculture in 1977. The downward trend in agricultural employment is expected to continue; therefore, in 2000, less than 5 percent of total county employment will be in agriculture. As a result, the likelihood of significant impacts on employment is small.

5.5.4.4 Impacts on Grazing Land

Data on irrigated acres in Daniels County vary by source selected. The Census of Agriculture reports 2,016 acres irrigated in 1974. The Montana State Department of Revenue reports irrigated acreage as 610 acres in 1974 and 2,029 acres in 1978. The Montana Department of Agriculture reports irrigated acreage as 2,500 acres in 1975, 2,900 acres in 1976, and 1,700 acres in 1977. Apparently there is a conflict in the definition of what constitutes irrigated land and whether wild hay lands are included. The above sources do not include wild hay land.

Grazing land is classified according to its carrying capacity. G2B is slightly better than average grazing land in Daniels County. Land is classified as G2B based on a combination of soil and other factors. It is generally not a cropland and may or may not be affected by flows in the Poplar River. So there is a possibility that the animal units supported by G2B lands could be reduced by the apportionment.

It is not possible to estimate accurately impacts on grazing lands without a detailed study of soils and sources of moisture. However, we can indicate the limits of the problem. If G2B lands amount to 33,760 acres, they constitute approximately 10 percent of the 325,000 acres of pasture and range lands in Daniels County. G3 lands require 28 to 37 acres per animal unit, and G2B lands require 22 to 27 acres per animal unit*. The 33,760 acres of G2B lands will carry approximately 1,400 animal units. If all are affected by the apportionment and reduced to G3, they could carry approximately 1,050 animal units, a reduction of 350 animal units.

---

*Byford (1980)

Using G3 lands as the average for grazing lands, the total animal unit capacity in Daniels County is approximately 10,000 animal units. Therefore, the maximum impact on carrying capacity is approximately 3%. It should be emphasized that the total impact on the livestock industry also depends on crop impacts and thus cannot be separated. As the experience of the recent drought illustrated the livestock sector is highly sensitive to water conditions.

5.5.4.5 Impacts on Riparian Lands

The natural flows vary considerably from year to year. Thus, the extent of spring flooding also varies. One effect of the apportionment would be to reduce the magnitude of spring flows. Flooding of the land along the river supplies soil moisture and flushes accumulated salts. Flooding on the East Fork with two 300 MW units operating is predicted to occur at approximately the same frequency (30 percent for a peak flow of at least 700 cfs for two consecutive days) as under natural conditions. With three or more units the frequency of flooding would decrease. Because of the annual variability and site-specific nature of flooding, it is difficult to assess the impacts of the apportionment on pasture and grazing land.

The impacts of the apportionment on riparian lands on the Fort Peck Indian Reservation depend upon whether the proposed storage reservoirs are built. If completed, spring flooding of lands bordering the lower Poplar River would be reduced and in very dry years precluded.

5.6 BIOLOGICAL IMPACTS

5.6.1 Impacts of Atmospheric Emissions on Terrestrial Biota

5.6.1.1 Effects on Vegetation and Crops

The effects of primary gaseous pollutants on terrestrial vegetation and animals can be categorized in terms of exposure duration and dosage. Three broad categories can be distinguished: acute, chronic and long-term. Acute effects are those which result from short-term exposures to relatively high concentrations of pollutants. Observable effects which result from exposures to comparatively low levels of pollutants for periods of months to years are referred to as chronic, while the effects of exposure to pollutants for decades or longer are classified as long-term.

Acute effects result from direct injury to the biota and are typified by leaf damage and lesions in an animal's respiratory tract or other serious debilities. While chronic effects may be expressed similarly to those which have been described as acute, more often they are expressed as subtle changes in the ecosystem. These subtle changes, moreover, may represent a change in the species composition of a well defined natural vegetation assemblage due to the loss of a pollutant sensitive species, or they may represent a decrease in numbers of wildlife in a particular area due to concomitant habitat depredation. Long-term effects on the other hand are the result of secondary or tertiary interactions and are always manifested as subtle changes in the ecosystem or an organism's susceptibility to respiratory diseases.

Sulfur dioxide (SO_2) is the most abundant gaseous pollutant produced by coal-fired electrical generating stations, and is therefore of primary concern when considering the impacts on terrestrial ecosystems. Nitrogen oxide emissions (NO_x) represent another important pollution source, but because expected concentrations produced in the vicinity of the plant are generally anticipated to remain below acute and chronic injury threshold levels, they are of secondary importance. In addition to considering the impacts associated with the emission of these common pollutants and their singular effects, the additive or possible synergistic effects must also be addressed.

Reported threshold limits of selected species to acute and in some cases chronic levels of SO_2, NO_x and combined gaseous emissions are provided in Table 5.6-1; included in this list are important species of grasses, forbs and cultivated crops found in the Poplar River impact area. These empirically determined threshold values represent upper levels of exposure at which no visible injury to the plants was observed. The values presented in Table 5.6-1 are greater than reported acute threshold levels listed for the most sensitive

Table 5.6-1

REPORTED THRESHOLD LIMITS OF IMPORTANT NATIVE PLANT AND CULTIVATED SPECIES FOUND IN THE IMPACT AREA TO GASEOUS SO_2, NO_x AND $SO_2 + NO_x$ EMISSION EXPOSURES

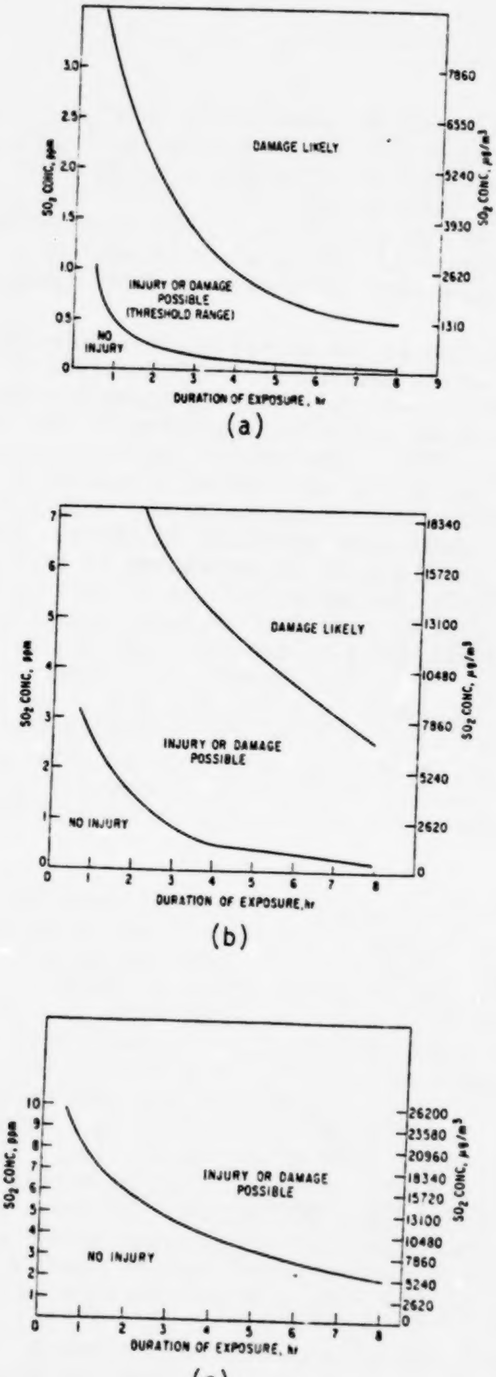
		THRESHOLD LIMITS (NO INJURY OBSERVED)	
Species	Gaseous Pollutant	Dose - Period of Exposure	Reference
Boutelova gracilis (blue gramma)	SO_2	0.5 ppm - 4 hrs	Tingey, et al., 1978
	SO_2	1.2 ppm - 3 hrs (biweekly)	Wilhour, et al., 1979
	NO_x	0.5 ppm - 4 hrs	Tingey, et al., 1978
	$SO_2 + NO_x$	(0.3 ppm + 0.1 ppm) - 4 hrs	Tingey, et al., 1978
Agropyron smithii (Western wheatgrass)	SO_2	1.5 ppm - 4 hrs	Tingey, et al., 1978
	SO_2	1.2 ppm - 3 hrs (biweekly)	Wilhour, et al., 1979
	SO_2	0.2 ppm - continuous during growing season	Dodd, et al., 1978
	NO_x	1.0 ppm - 4 hrs	Tingey, et al., 1978
	$SO_2 + NO_x$	(0.3 ppm + 0.1 ppm) - 4 hrs	Tingey, et al., 1978
Artemisia frigida (finged sagewort)	SO_2	1.0 ppm - 4 hrs	Tingey, et al., 1978
	NO_x	4.0 ppm - 4 hrs	Tingey, et al., 1978
	$SO_2 + NO_x$	(0.6 ppm + 0.1 ppm) - 4 hrs	Tingey, et al., 1978
Koeleria cristata (praire june grass)	SO_2	1.0 ppm - 4 hrs	Tingey, et al., 1978
	SO_2	1.2 ppm - 3 hrs (biweekly)	Wilhour, et al., 1979
	NO_x	1.0 ppm - 4 hrs	Tingey, et al., 1978
	$SO_2 + NO_x$	(0.3 ppm + 0.1 ppm) - 4 hrs	Tingey, et al., 1978
Stipa comata (needle and threadgrass)	SO_2	1.5 ppm - 4 hrs	Tingey, et al., 1978
	SO_2	1.2 ppm - 3 hrs (biweekly)	Wilhour, et al., 1979
	NO_x	1.0 ppm - 4 hrs	Tingey, et al., 1978
	$SO_2 + NO_x$	(1.2 ppm + 0.1 ppm) - 4 hrs	Tingey, et al., 1978
Medicago sativa (Alfalfa)	SO_2	1.15 ppm - 1 hr	Stevens and Hazelton, 1976
	SO_2	0.50 ppm - 3 hrs	Stevens and Hazelton, 1976
	SO_2	0.25 ppm - 24 hrs or more	Stevens and Hazelton, 1976
	SO_2	1.2 ppm - 3 hrs (biweekly)	Wilhour, et al., 1979
Hordeum vulgare (Barley)	SO_2	0.70 ppm - 1 hr	Dreisinger and McGovern, 1970
	SO_2	0.46 ppm - 2 hrs	Dreisinger and McGovern, 1970
	SO_2	0.27 ppm - 4 hrs	Dreisinger and McGovern, 1970
	SO_2	0.14 ppm - 8 hrs	Dreisinger and McGovern, 1970
	SO_2	1.2 ppm - 3 hrs (biweekly)	Wilhour, et al., 1979
Tritcum aestivium (hyslop wheat)	SO_2	0.6 ppm - 4 hrs	Tingey, et al., 1978
	SO_2	1.2 ppm - 3 hrs (biweekly)	Wilhour, et al., 1978
	NO_x	2.0 ppm - 4 hrs	Tingey, et al., 1978
	$SO_2 + NO_x$	(0.6 ppm + 0.1 ppm) - 4 hrs	Tingey, et al., 1978

plant species which are presented graphically in Figure 5.6-1. The concentrations and corresponding exposure shown in Figure 5.6-1, however, represent threshold levels for plants growing under the most sensitive conditions and stage of maturity. While such guidelines for chronic exposures are not available, it has been estimated that an ambient SO_2 concentration of 130 $\mu g/m^3$ (0.05 ppm) on a seasonal or annual average basis represents the threshold level (Mukammal, 1976).

Studies were conducted at the Corvallis Environmental Research Laboratory during the spring and summer months of 1977 to investigate the effects of both chronic and multiple SO_2 exposures on selected small grains, native range grasses and alfalfa growing in the Poplar River Basin (Wilhour, et al., 1979). The results indicated that the yield of duram wheat and barley may be substantially reduced by weekly 72-hr exposures to SO_2 concentrations of approximately 0.15 ppm (400 $\mu g/m^3$) and that spring wheat, while more resistant to chronic exposures, may also suffer decreased yield due to SO_2 exposures at similar levels. Multiple exposure of these species as well as alfalfa to frequencies varying from once per week to once in five weeks with SO_2 concentrations up to 0.12 ppm (320 $\mu g/m^3$) for 3-hr periods, however, had no effect on the yield of the plants. Finally, biweekly exposures for 3-hr at concentrations up to 1.2 ppm (3200 $\mu g/m^3$) had no effect on the growth of either the roots or tops of alfalfa or the following five species of native grasses: crested wheatgrass *(Agropyron desertorum)*, western wheatgrass *(Agropyron smithii)*, Russian wild ryegrass *(Elymus junceus)*, blue gramma grass *(Bouteloua gracilis)* and needle and thread grass *(Stipa comata)*.

The combined effects of gaseous emissions, especially the interaction of SO_2 and NO_x, on vegetation are not well understood, and some controversy exists concerning possible synergistic or additive effects. Studies conducted in growth chambers (Bennett, et al., 1975) indicated that SO_2 and NO_x applied in combination may enhance the deleterious effect of these pollutants; relatively high doses of these pollutants, however, were required to cause visible injury. For example, one hour exposures to a 0.5 ppm SO_2 + NO_x (960 $\mu g/m^3$ NO_x and 1330 $\mu g/m^3$ SO_2) mixture or to 0.75 ppm (1950 $\mu g/m^3$) were required to cause visible foliar injury in the most sensitive species. Other studies (Tingey, et al., 1978 and Hill, et al., 1974) have been unable to substantiate that mixtures of SO_2 + NO_x interact to cause greater foliar injury than equal concentrations of single gaseous pollutants. The acute tolerance levels of several plant species found within the impact area to mixtures of SO_2 + NO_x are indicated in Table 5.6-1.

Based on the conservative projections provided by the CRSTER air quality model, gaseous emissions resulting from the operation of the proposed generating station will not have a detectable impact on the terrestrial ecosystem. This analysis is based on the specific considerations outlined below, but generally is the result of the absence of industrial and urban development within the Poplar Basin and the concomitant excellent baseline air quality conditions. As previously



Source: U.S. EPA, 1973

Figure 5.6-1 DOSE-INJURY CURVES FOR (a) SO$_2$-SENSITIVE PLANT SPECIES, (b) PLANT SPECIES OF INTERMEDIATE SO$_2$ SENSITIVITY, AND (c) SO$_2$-RESISTANT PLANT SPECIES.

noted, however, the CRSTER model does not incorporate fumigation events in estimating pollutant concentrations. Estimated maximum ground-level concentrations of gaseous emissions during morning plume fumigation for the worst case atmospheric conditions are of the same magnitude as concentrations associated with acute injury levels for the most sensitive plant species. The possible impact of estimated peak concentrations resulting from plume fumigation are discussed in a subsequent section.

The area of primary concern for the evaluation of emission impacts is that region within a 50 km (31.1 miles) radius of the plant site. Assuming the operation of four 300 MW units, the yearly maximum 24-hour concentration of SO_2 predicted by the air quality model to occur at a distance of 50 km is 22.8 $\mu g/m^3$ or 0.008 ppm; this value is below the minimum detectable limits of baseline measurements in this area. The projected maximum 1-hour SO_2 concentration at this distance at this same electrical generating capacity is 169 $\mu g/m^3$ or 0.06 ppm, and this projected concentration is an order of magnitude less than reported concentrations associated with acute injury threshold levels for sensitive vegetation. The projected ambient concentrations of NO_x for this region are similarly below threshold injury levels for sensitive native plants and crops. These projected concentrations for SO_2 and NO_x are of particular importance since the air quality model is especially conservative at this distance from the point source. The region described here as the area of primary concern is shown in Figures 5.1-1 through 5.1-4; it lies within Daniels and Valley Counties and represents a total area of approximately 700 km^2 (270 square miles).

That portion of the impact area continuously exposed to the highest concentrations of gaseous emissions and therefore most likely to display the acute and chronic effects of exposure to SO_2 and NO_X is within 6-15 km (3.7-9.3 miles) of the stacks. The yearly maximum 1-, 3- and 24-hour ambient SO_2 concentrations projected for any area within this range (for a 1200 MW plant with 0 percent SO_2 control) are 428 $\mu g/m^3$ (0.16ppm), 192 $\mu g/m^3$ (0.07 ppm) and 56 $\mu g/m^3$ (0.02 ppm). The projected maximum annual mean SO_2 concentration at this distance is 4.8 $\mu g/m^3$ (<0.01 ppm). Higher short-term ambient SO_2 concentrations were predicted by Gelhaus (1980). However, both sets of projected SO_2 concentrations as well as those of NO_X are considerably less than those associated with acute and chronic threshold injury levels for sensitive vegetation. Moreover, the projected levels of these pollutants in combination are below reported concentrations associated with combined or synergistic effects. As previously noted, experiments using the most sensitive native grasses found that 4-hour exposures to combined concentrations of 798 $\mu g/m^3$ (0.3 ppm) SO_2 and 192 $\mu g/m^3$ (0.1 ppm) NO_2 were insufficient to induce foliar injury (Tingey, et al., 1978).

The preceding comparisons which indicate the absence of injurious SO_2 levels resulting from the Poplar River plant were all based on the maximum projected emissions at the site, i.e., operation of four 300 MW units with 0 percent SO_2 control. The maximum concentrations occurring near the plant site were also considered. The actual concentrations of gaseous constituents, and the corresponding potential for foliar injury, would be considerably less due to the following factors:

1) Operation of two units would result in correspondingly lower emission rates.

2) The use of stack emission controls would result in reductions in ambient SO_2 concentrations.

3) The ambient concentrations of all constituents decrease rapidly with distance from the site. Therefore, most of the Poplar basin would be exposed to maximum projected concentrations greater than two orders of magnitude below the tolerance levels for local agricultural plant species.

5.6.1.2 Potential for Acidification of Soils

Areas not subjected to acute or chronic SO_2 exposure can nevertheless be affected by long-term, low level ambient SO_2 concentrations. The most widely recognized effect of long-term exposures to elevated sulfur levels is the acidification of soils (Nyborg, 1978). Additionally, recent studies (Rice, et al., 1979) suggest that a long-term buildup of sulfur in plants could have a detrimental effect on crop yield and quality. However, no studies have been conducted to determine a relationship between excessive sulfur accumulation and plant damage.

The acidification of soils can result from the deposition of sulfur and nitrogen in precipitation (acid rain) as well as the formation of sulfuric and nitric acid on or in the soil following direct dry deposition of SO_2. The effects on soils are: an increased availability of aluminum (Al^{3+}) and manganese (Mn); deficiency in soil concentrations of calcium (Ca) and magnesium (Mg); and increased hydrogen ion (H^+) concentrations. These changes in soil chemistry can affect plant growth and yield. The primary manner in which soil acidity affects plant growth is through aluminum toxicity which begins to occur at a pH around 5.0-5.5. In the presence of adequate phosphorus, the aluminum may precipitate out, mitigating against this problem. Calcium and magnesium deficiencies are primarily a problem associated with forest soils which are naturally acidic. Increased H^+ ion concentrations are generally toxic to plant roots only when soils are extremely acidic (pH = 4.0 to 3.0). Nitrogen fixation by symbiotic bacteria is inhibited at low pH levels but adaption may compensate for this.

While the accumulation of sulfur can have deleterious effects, sulfur is also an essential nutrient. The amount of sulfur needed for medium to high crop yields ranges from about 10 to 40 kg/ha yr-1 (Noggle and Jones, 1979). At least a portion of a plant's sulfur requirements can be met by direct uptake of SO_2 from the atmosphere if present at low concentrations (Faller, 1971; Bromfield, 1972; Cowling, et al., 1973; Noggle and Jones, 1979). Beneficial effects of ambient low level SO_2 concentrations on plant growth when soil concentrations are inadequate have also been demonstrated (Faller, 1970 and 1971). In addition, sulfur in the form of calcium sulfate (gypsum) is often applied to soils to change part of the caustic alkali carbonates into leachable sulfates.

The nature of soils also affects the degree of environmental impact. The soils in the Poplar River Basin are moderately calcareous; (average - 4 percent calcium equivalent on a weight basis, Smetana (personal communication)). While soil acidification can be a problem in areas exposed to SO_2 emissions, the impact is minimized by calcareous soils (Nyborg, 1978). Based on the buffering capacity of soils in the impact area assuming a 4 percent $CaCO_3$ concentration, a soil depth of 50 cm, the deposition of 50 kg/ha of elemental sulfur and the subsequent conversion of this total amount of sulfur to H_2SO_4, no significant change in soil pH would occur.

Sulfur can also be removed by cropping following plant uptake, by the leaching of soluble sulfates, and by surface drainage. For example, Likens, *et al*., (1967) found that the loss of sulfur (9.8 kg S/ha) in the drainage for a catchment area in New Hampshire was approximately equal to sulfur inputs associated with precipitation (10 kg/ha). Plants themselves provide a sink for sulfur emissions. A portion of the sulfur that is in a form available to plants during the growing season (the soluble inorganic sulfate, adsorbed sulfate) is assimilated by the vegetation. As much as 50 percent of this organic sulfur can be removed from the system by cropping, while the remainder returns to the soil as organic material. This organic material again becomes available to the sulfate pool through mineralization.

An assessment of the impacts of sulfur deposition on soils must consider not only SO_2 deposition rates but also buffering capacity of the soils and sulfur loss through cropping and leaching. Sulfur emitted to the atmosphere by a power plant can be introduced into the terrestrial ecosystem by wet and dry deposition. There are two methods of estimating the rate deposition of sulfur. The first is based on the assumption that the total amount of sulfur in stack emissions will be equally distributed within a specified area. A second method is based on a calculation of deposition rate as the product of an annual mean SO_2 concentration and an estimated deposition velocity (Fowler, 1978; Garland, 1978).

The first method was used by the Montana Department of Health and Environmental Sciences (MDHES) to predict sulfur deposition within the Poplar River Basin (Gelhaus and Roach, 1979). The estimate was based on the following assumptions: the operation of a 300 MW plant with zero percent SO_2 control, daily SO_2 emissions of $5.84 \cdot 10^4$ kg (6.4 tons), 60 percent deposition of sulfur emissions within a 40 km radius of the source, and equal deposition throughout the affected area. The predicted deposition rate was 25.5 kg/ha yr^{-1} of SO_2 or approximately 12.8 kg/ha yr^{-1} of elemental S. An annual deposition rate of 12.8 kg S/ha for the 300 MW plant is equivalent to deposition rates of 25.6 and 51.2 kg S/ha yr^{-1} for the 600 and 1200 MW plants, respectively.

The second method focuses on the contribution of dry deposition to total annual inputs of sulfur. Measurements of the deposition velocity range from 0.3 cm/sec to 1.25 cm/sec over soil, crop and other vegetation surfaces (Garland, 1978). These deposition velocities are substantially greater over vegetative surfaces during periods of maximum growth as well as during daylight periods. In order to estimate a dry deposition rate of SO_2 within the Poplar River Basin, conservative values for both the mean concentrations as well as deposition velocities were selected. Accordingly, the annual mean concentration of SO_2 was taken to be 4.2 μg/m^3 (the maximum annual average SO_2 concentration predicted by the CRSTER model for a 1200 MW power plant with zero percent SO_2 control). The selected deposition velocity (0.8 cm/sec) is the estimated value for daylight periods during the growing season. Based on these parameters the estimated annual dry deposition rate is 10.6 kg/ha SO_2 or 5.3 kg/ha elemental S.

Wet deposition represents another mechanism for transport of atmospheric sulfur to the soil. However, given the low levels of precipitation in the Poplar River Basin as well as the low ambient concentrations of SO_2, expected sulfur inputs associated with precipitation would be less than dry deposition rates and will most likely make only a fractional contribution to total sulfur deposition.

The underlying assumptions of the two estimates of annual sulfur deposition described above have a substantial effect on the predicted values (51.2 kg S/ha yr^{-1} for a 1200 MW plant in the first estimate versus 5.3 kg S/ha yr^{-1} in the latter). The first estimate assumed 60 percent deposition within 40 km of the source. However, the rate of dry deposition (the most important source in semi-arid regions) in an area surrounding the emission source is related to the product of the inversion height and the ratio of the mean wind speed to the deposition velocity. Concentration decay distances of several hundred kilometers have been reported (Scriven and Fisher, 1975). The result of this simplified accounting of total deposition is a very conservative estimation of annual sulfur deposition per unit area.

5.6.1.3 Effects of Fumigation

Plume fumigation may occur during certain stable atmospheric conditions and result in the exposure of vegetation to substantially higher than usual concentrations of gaseous emissions. The estimated maximum exposure levels of SO_2 and NO_x emissions are presented in Table 5.1-4. The concentrations of SO_2 expected to occur during fumigation under the most stable atmospheric conditions and maximum power generating capacity (1200 MW) range between 1.0 and 1.5 ppm (Table 5.1-4), while concentrations associated with average meteorological conditions at Scobey are less than 0.7 ppm (Table 5.1-5). The maximum SO_2 concentrations with only two 600 MW units operating are 0.7 ppm (Table 5.1-4) and 0.3 ppm (Table 5.1-5) under severe and typical stability conditions, respectively. Higher concentrations up to 2.9 ppm at a 6 km distance from the plant were predicted by Gelhaus (1980) when two 600 MW units are operating, although these values appear to be in error. Information was not provided in sufficient detail to duplicate the calculations. When an attempt was made to recalculcate the values, they could not be duplicated.

The fumigation concentrations are compared to the threshold limits for the most sensitive species to SO_2 (EPA 1973) of 0.5 ppm (1,330 ug/m^3). The one hour threshold limit for possible damage to barley at 0.7 ppm (Dreisinger and McGovern, 1970) and alfalfa at 1.15 ppm (Stevens and Hazelton, 1976) are above this lowest threshold limit. Comparison of

SO_2 plant tests and fumigation concentrations with two 300 MW units operating indicate no damage under typical stability conditions at distances greater than 7 km from the power plant and with up to one hour exposures. Under more severe stability conditions, some damage is possible to SO_2 sensitive species at distances between 6 and 10 km if exposures for one hour occur at levels greater than 0.5 ppm (1,330 ug/m). However, away from the plume centerline the concentrations decrease so that at a distance of 500 m the concentration is only 25 percent of the value at the centerline.

If fumigation occurred for 15 minutes, ambient standards can be violated for short time periods. Using the fumigation estimates under typical meteorological conditions and estimated ambient concentrations at 6 km, ambient standards are violated for a 1200 MW plant but not for a 600 MW plant. Using Gelhaus' (1980) estimates for fumigation and ambient concentrations, violations occur for a 600 and 1200 MW plant. While this is true under certain conditions, the area involved would be small. It is also not clear that short-term fumigation events should be compared to ambient air quality standards.

Concentrations above 0.5 ppm have been shown to cause foliar damage to some of the most sensitive plants when subjected to short-term exposure experiments; however, the sensitivity of these plants were determined in experiments in which the duration of exposure was one or more hours (U.S. EPA, 1973). The predicted fumigations are generally of short duration, persisting for periods up to 30-45 minutes (Portelli, 1975). Comparison of the estimated maximum SO_2 concentrations expected during fumigation with reported threshold limits of important native and cultivated plants found in the impact area (Table 5.6-1) indicate that the risk of SO_2 damage is minimal.

The maximum NO_x and particulate concentrations due to fumigation at a distance of 10 km from the power plant are estimated as follows:

	600 MW	1200 MW
NO_x, ug/m^3	676(306)[a]	1352(612)
Particulates, ug/m^3	85(30)	170(76)

[a] The values in parentheses are for typical meteorological conditions. The higher values are for more severe conditions.

The estimated maximum concentrations of NO_x over one hour were given by Gelhaus (1980) as 687 ug/m^3 for a 600 MW plant and 1374 ug/m^3 for a 1200 MW plant. If the maximum concentrations predicted persist for 45 min., violations of Montana's ambient one-hour standard for NO_x of 564 ug/m^3 would be violated for both the 600 MW and 1200 MW. There are no ambient standards for particulates for a period less than 24 hours.

Experiments on effects of NO_x on vegetation were available for exposures of 4 hours or more. As stated earlier, it is difficult to relate these data to high level short-term exposures. The lowest threshold limit of no damage by NO_x was 0.5 ppm (960 ug/m^3) for 4 hours for blue gramma grass (Tingely, et al., 1970). The estimated concentrations here would be below this threshold limit.

During fumigation events vegetation will be simultaneously exposed to elevated concentrations of NO_x, O_3 and SO_2. As an indication of the increased susceptibility of vegetation to injury from combinations of gaseous emissions, a review of the literature (Linzon, 1978) found that a low concentration of 0.10 ppm SO_2 in combination with either O_3 or NO_x for periods of 4 hrs can injure a wide variety of plants. The problem with projecting impacts due to the synergistic effects of emission gases based on values from the literature, however, is that the determination of threshold limits has been made at relatively long periods of exposure when compared to the duration of fumigation events. Examination of Table 5.6-1, for example, indicates a threshold level for hyslop wheat (*Tritcum aestivium*) for 4 hr exposures at combined concentrations of 0.6 ppm and 0.1 ppm for SO_2 and NO_x, respectively. While combined concentrations of SO_2 and NO_x approximating these levels may occur as maximum ground-level concentrations during fumigation, the periods of exposure will be much less than 4 hours. Evidence to equate predicted gaseous concentrations during fumigations to established acute threshold levels was not found.

Factors other than temporal instability will also act to minimize the possibility for either losses in plant productivity or damage to vegetation in the impact area. The ground-level area fumigated during an inversion breakup is contained within a relatively narrow band beneath the originally stable plume. At a distance of 10 km from the emission source, for example, the concentration of gaseous emissions is decreased by a factor of four at a distance of 500 m from the plume centerline and is less than 1 percent of the maximum concentration at 1000 m from the centerline. Moreover, the location of the plume fumigation is determined by wind direction. The chances of detecting fumigations are very small unless the same area is fumigated repeatedly and only a very restricted area is exposed to these higher SO_2 concentrations during each event. Finally, the actual region within the impact area which will be potentially exposed to fumigation consists of a 10-km wide band between 10 and 20 km from the power plant and between the 110^o and 250^o azimuths.

5.6.1.4 Effect of Particulate Emissions

Based on the results of the air quality simulation model, it was concluded that no impacts on the terrestrial ecosystem would be observed as the result of direct contact with particulate emissions in the atmosphere. Projected increased annual average ambient particulate concentrations are less than 0.4 $\mu g/m^3$ (1200 MW plant with 99 percent control) within the impact area and, as previously indicated, meet both U.S. and Montana State air quality standards.

Further analyses, however, were conducted in order to assess the possible long-term impacts associated with the deposition of trace elements and their subsequent accumulation within the food chain. Toxic levels of trace elements may accumulate in the tissue of plants indirectly by the uptake of soluble elements from the soil. It has further been shown that bioaccumulation of toxic concentrations of trace elements can occur at successive levels in the food chain following initial uptake and translocation by vegetation.

The methodology used in the impact assessment of trace element deposition was similar to those utilized by Dvorak, et al., 1977. Accordingly, the following conservative assumptions were made in order to establish worse case projections:

1) The deposition of all emitted particulates occurs within a 80.5 km (50 miles) radius of the generation site.

2) The particulates are evenly distributed within the impact area.

3) Emission rates of trace elements are the product of the concentration of the dust collector ash and the estimated particulate emission rate (4899 kg/day).

4) All deposited trace elements reach the soil and are retained in the top 3 cm.

5) Trace elements move into the root zone and remain totally available for uptake by vegetation.

These assumptions must be considered extremely conservative due to the physical characteristics of emitted particulates as well as the behavior of trace elements in the soil. Particulate emissions escaping 99.5 percent electrostatic precipitators are very fine and exhibit a gas-like behavior. Vaughan, et al., (1975), for example, predicted that only 6 percent of the total emissions would be deposited within a 50-km radius of their model plant. Additionally, while it is assumed that trace elements remain totally available to plant uptake and are readily transported to edible portions of the plants, available evidence indicates that the absorption and translocation of these elements are, in fact, limited by a number of factors.

The projected percent increases in soil and aerial plant parts occurring over a 30-year period as well as the important intermediate calculations made in this analysis are shown in Table 5.6-2. Based on these results it is anticipated that the deposition of trace elements will not have an adverse impact on the terrestrial ecosystem. The projected increased concentrations in the soil during the 30-year period are less than 0.20 percent for each of the selected elements. Moreover, the predicted increased concentration of trace elements in aerial portions of plants are below reported toxic levels summarized by Dvorak, et al., (1977).

The projected increases in several trace element concentrations may also be compared with baseline concentrations in selected agricultural plant species reported by Braun, 1978. The ranges of concentrations measured in samples from 14 sites near the International Boundary are presented in Table 5.6-3. The tabulated concentrations of lead, cadmium, arsenic and selenium are for samples collected during the late summer of 1977. Samples were also collected in early summer, at which time most of the constituent concentrations were slightly less than or about equal to the late summer values. The notable exception is selenium, which displayed early-summer concentrations of 80-84 μg/g in grasses and forbs at two of the sites.

Table 5.6-2

PROJECTED DEPOSITION RATES, SOIL CONCENTRATIONS AND PLANT ACCUMULATION OF 17 TRACE ELEMENTS RESULTING FROM PARTICULATE EMISSIONS

	Emission Rate g/day	Trace Element Deposition g/m^2/30 year	Increased Soil Concentration[1] (μg/g) 3 cm Depth	Average Soil Concentration (μg/g)	Increase Over Total Endogenous Concentrations Percent	Plant: Soil Concentration Ratio[2]	Increased Concentrations in Aerial Plant Parts[3] (μg/g dry weight)
Lead	784	4.0×10^{-4}	$.9 \times 10^{-3}$	10	.09	2	0.02
Mercury	0.441	2.37×10^{-7}	5.4×10^{-6}	-	-	26	-
Antimony	48	2.58×10^{-5}	6.0×10^{-4}	-	-	-	-
Cadmium	1.18	6.35×10^{-7}	1.4×10^{-5}	0.06	0.02	222	0.003
Silver	0.83	4.47×10^{-7}	1.0×10^{-5}	-	-	-	-
Selenium	14.21	7.65×10^{-6}	1.7×10^{-4}	0.5	0.03	4	0.0007
Arsenic	36.25	1.95×10^{-5}	4.42×10^{-4}	6.0	0.007	4.2	0.002
Germanium	8.8	4.74×10^{-6}	1.1×10^{-4}	-	-	-	-
Zinc	122.5	6.59×10^{-5}	1.5×10^{-3}	50	0.003	40	0.06
Copper	181.3	9.76×10^{-5}	2.2×10^{-3}	20	0.01	1000	2.20
Nickel	53.89	2.90×10^{-5}	6.6×10^{-4}	40	.002	331	0.22
Cobalt	29.39	1.58×10^{-5}	3.6×10^{-4}	8	.005	87	0.03
Manganese	2939.4	1.58×10^{-3}	3.6×10^{-2}	850	.004	3000	108.0
Chromium	333.13	1.79×10^{-4}	4.1×10^{-3}	100	.004	250	1.03
Vanadium	156.77	8.44×10^{-5}	1.9×10^{-3}	100	.002	1	0.002
Boron	1469.7	7.91×10^{-4}	1.8×10^{-2}	10.0	0.18	-	-
Beryllium	2.25	1.21×10^{-6}	2.7×10^{-5}	6.0	.0005	16	.0004

[1] Assumes bulk density of soil is 1.47 g/cm^3.

[2] These concentration ratios were derived by Vaughn, et al. (1975) and express the potential uptake capacity of various plant species for indicated trace elements.

[3] Assumes the concentration of trace elements deposited in the top 3 cm of soil moves into the root zone and is totally available for uptake by the vegetation.

Table 5.6-3

MINIMUM AND MAXIMUM CONCENTRATION OF TRACE ELEMENTS IN POPLAR RIVER BASIN VEGETATION (μG/G) SAMPLES COLLECTED DURING THE LATE SUMMER OF 1977

	Pb	Cd	As	Se
Grasses and Forbs	0.20- 8.3	0.05-0.32	<0.05-0.17	<0.05-0.52
Spring Wheat				
- Stems	0.6 - 2.0	0.01-0.35	<0.05-0.20	0.08-0.38
- Heads	14.1 -67.6	0.01-0.16	<0.05-0.06	0.08-0.85
Alfalfa	0.2 - 1.0	0.05-0.14	<0.05-0.08	0.07-0.35

A comparison of background trace element levels with predicted concentrations following 30 years of power plant operation indicates that there would be negligible increases in vegetation levels of the four measured elements. For example, the predicted increase in lead is only 10 percent of the lowest background lead concentration in grasses and forbs (0.20 μg/g), and represents only 2.4 percent of the corresponding maximum value. The percent increases above background are even less for lead levels in stems and heads of spring wheat.

5.6.2 Impacts of Atmospheric Emissions on Aquatic Biota

Atmospheric emissions from the Poplar River Power Plant may potentially effect the following surface water quality parameters: acidity, nutrient availability and trace element concentrations. The potential for each of these effects is discussed in subsequent sections.

5.6.2.1 Acidification and Nitrogen Loading

Emission of SO_2 and NO_x may contribute towards increasing the **acidity of precipitation by the formation of strong acids.** Subsequent reductions in the pH of surface waters may result if the natural soil or water buffering capacity is low. Regional acidification, presumably enhanced by combustion product emissions, has been observed in several areas of the world, including the Adirondack Mountain Lakes of Northern New York State. A regional analysis indicates, however, that there is an extremely low potential for surface water acidification in the Northern Great Plains (Dvorck, et al., 1977). This results primarily from the alkaline nature of soils and surface waters, and the clay component of soils in the Poplar River Basin.

Similarly, atmospheric NO_x emissions are expected to result in no appreciable increase in nitrogen loading of surface waters which would result in increased eutrophication. The Upper East Fork currently displays indications of a eutrophic status based on inorganic nitrogen and phosphorus concentrations and the abundant macrophyte growths. Based on observations by Klarich (1978) the Poplar River system is nitrogen-limited; therefore, increased inorganic nitrogen concentrations could potentially result in a concomitant increase in algal or macrophyte growth. However, during the period of maximum potential plant growth (i.e., summer) atmospheric NO_x is generally not available for introduction into surface waters due to the lack of precipitation. Even during periods of heavy precipitation or runoff the transport of atmospheric inorganic nitrogen to surface waters would be minimal due to the low concentrations and utilitzation by terrestrial flora.

5.6.2.2 Trace Element Contamination

A number of trace elements occur in flyash following coal combustion and are generally emitted in conjunction with the particulate matter except mercury which is emitted as a vapor.

Trace elements emitted as stack discharges may eventually be introduced into streams, resulting in increased concentrations above background levels. The mechanisms and magnitude of transport into waterbodies are quite complex, however, and depend on the following factors:

1) terrestrial deposition rate
2) water flow characteristics (e.g., surface runoff or groundwater)
3) soil chemistry (especially CEC and pH)
4) aquatic chemistry (especially suspended solids, alkalinity, pH).

In order to assess the potential for increased concentrations of trace elements in the Poplar River due to atmospheric emissions, the potential riverine concentrations were calculated using a simplified direct-transport approach. In estimating potential aquatic impacts, the following assumptions were used:

1) Sixty percent of the total particulate emissions would be deposited with the Poplar River drainage basin.
2) The total daily deposition of particulate matter would be dissolved into the average expected daily flow of the Poplar River.

Due to the very conservative nature of the aforementioned assumptions, the resultant estimates are actually the maximum potential concentrations. The particulate emission rate was assumed to be 4898.9 kg/day, which corresponds to two 300 MW units with 99.5 percent electrostatic precipitators. Trace element concentrations in particulate emissions were assumed to equal the concentrations measured in dust collector ash of Poplar River coal samples (see Table 5.6-4).

The results of these analyses indicate that the addition of trace elements derived from Poplar River Power Plant stack emissions would not result in appreciable elevations of background concentrations (Table 5.6-5). In most cases, calculated concentrations are considerably less than 1 μg/ℓ and represent only a small percentage of natural constituent concentrations. Moreover, when compared with Water Quality Criteria for the protection of aquatic life (EPA, 1976), the calculated increases do not result in any concentration (background and addition) exceeding the corresponding criteria value (Table 5.6-5). Trace elements can also accumulate in the snow and enter rivers as a slug during the spring but the concentrations would still not be significant.

It should again be emphasized that the preceding calculations represent maximum potential values. The actual increases and potential effects on aquatic biota would probably be considerably less due to:

Table 5.6-4

TRACE ELEMENT CONCENTRATIONS (PPM) IN POPLAR RIVER COAL ASH SAMPLES

	Upper Ash	Dust Collector Ash
Lead	110	160
Mercury	0.07	0.09
Antimony	5.6	9.8
Cadmium	0.24	0.24
Silver	0.17	0.17
Selenium	0.41	2.9
Arsenic	0.74	7.4
Germanium	0.91	1.8
Zinc	25	25
Copper	21	37
Nickel	7.5	11
Cobalt	5.1	6
Manganese	300	600
Chromium	170	68
Vanadium	48	32
Boron	100	300
Beryllium	<0.10	0.46

Source: Accu-labs Research, Inc. (1978).

Table 5.6-5

AVERAGE TRACE ELEMENT CONCENTRATIONS (μG/ℓ) IN THE POPLAR RIVER AND PROJECTED INCREASES DUE TO ATMOSPHERIC EMISSIONS OF THE POPLAR RIVER POWER PLANT

	Median Concentration[1]	Maximum Concentration[1]	Input from Atmospheric Emissions[2]	Quality Criteria for Aquatic Life (EPA, 1976)	Criteria Estimate[3]
Lead	2	5	1.6	0.01 96-h LC50	∿2000
Mercury	0	2.8	0.0009	0.05	
Antimony	-	-	0.10	[4]	
Cadmium	<1	1	0.0025	12.0	
Silver	-	-	0.0018	0.01 96-h LC50	∿50
Selenium	<0.2	1.6	0.030	0.01 96-h LC50	∿20
Arsenic	2	27	0.076	50[5]	
Germamium	-	-	0.019	[4]	
Zinc	10	30	0.259	0.01 96-h LC50	∿50
Copper	1	9	0.383	0.01 96-h LC50	∿50
Nickel	3	6	0.114	0.01 96-h LC50	∿200
Cobalt	-	-	0.062	[4]	
Manganese	60	200	2.69	1,500[6]	
Chromium	0	10	0.704	100	
Vanadium	1	5	0.331	[4]	
Beryllium	0	10	0.048	1,100	
Boron	1,000	4,100	3.11	18×10^6[7]	

[1] Average for Poplar River from Klarich, 1978.

[2] Based on daily dilution in average Poplar River Flow.

[3] Based on reported toxicities in water quality similar to that of Poplar River.

[4] No criterion for protection of aquatic life.

[5] No criterion - domestic water supply criterion should protect aquatic life.

[6] No criterion - threshold for sensitive species.

[7] No criterion - lethal dose for minnows.

1) Much lower terrestrial deposition rates. Vaughn, et al., 1975, indicates that only about 6 percent of particulates would generally be deposited within a 50-mile radius.

2) Retention of trace elements in soil will prevent groundwater or surface water contamination. The alkaline nature of Poplar River Basin soils and the moderate cation exchange capacity would tend to limit groundwater transport.

3) Reduction of concentrations and toxic effects in surface waters. The solubility and resultant toxicity of heavy metals is considerably reduced in waters of high alkalinity and pH.

5.6.3 Impacts of Water Quality Changes on Fish and Wildlife

Operation of the Poplar River Power Plant in conjunction with flow apportionment will affect downstream water quality in the U.S. part of the basin. Changes in a number of constituents have been predicted by the water quality modeling studies outlined in Section 5.3. Several of these constituents have a high potential for direct impacts on aquatic biota. The effects of changes in thermal regimes, dissolved oxygen and dissolved solids are discussed in the following sections. Other constituents which are considered to be of very low potential for impact on aquatic life are also discussed in less detail.

5.6.3.1 Effects of Thermal Discharges

The once-through cooling water discharge for the Poplar River plant is located near the reservoir release point at the dam. Therefore, there is a potential for heated waters to be released into the East Fork during reservoir spill or scheduled releases. The following section provides a discussion of the downstream temperature elevations and the potential for effects on aquatic life.

The magnitude of temperature elevations (ΔT's) downstream from Cookson Reservoir was examined by Spraggs (1977). The methodology used was a two-step modeling approach in which the thermal regime of Cookson Reservoir was simulated with both one- and two-unit operation (300 and 600 MW). The output of the layered one-dimensional reservoir model was then used as input into a fully mixed one-dimensional stream model to predict downstream temperature increases from the dam to the International Boundary.

The reservoir model indicated that for one-unit operation (at a plant $\Delta T = 10°C$) the reservoir releases would be at a maximum ΔT of 5°C. For two units, the releases would be at the full power plant ΔT of 10°C. When these release ΔT's are used in the stream model, a complete return to natural ambient temperature was predicted to occur within the Canadian part of the basin during the low-flow months of August through September. During June and July, a 10°C reservoir release (i.e., two

300 MW units) would result in temperature elevations at the International Boundary of only 1.2°C (Figure 5.6.2). The greatest downstream effect on ambient temperature was predicted in May when a 10°C increase would occur at the boundary during a 10°C ΔT reservoir release.

The modeling results are substantiated by using the surface heat exchange equation of Edinger, et al. (1975):

$$TS = TN + TD^{-K(A/Q)}$$

where

TS = predicted temperature

TN = natural temperature

TD = temperature of reservoir release

K = surface heat exchange coefficient

A = area of river reach

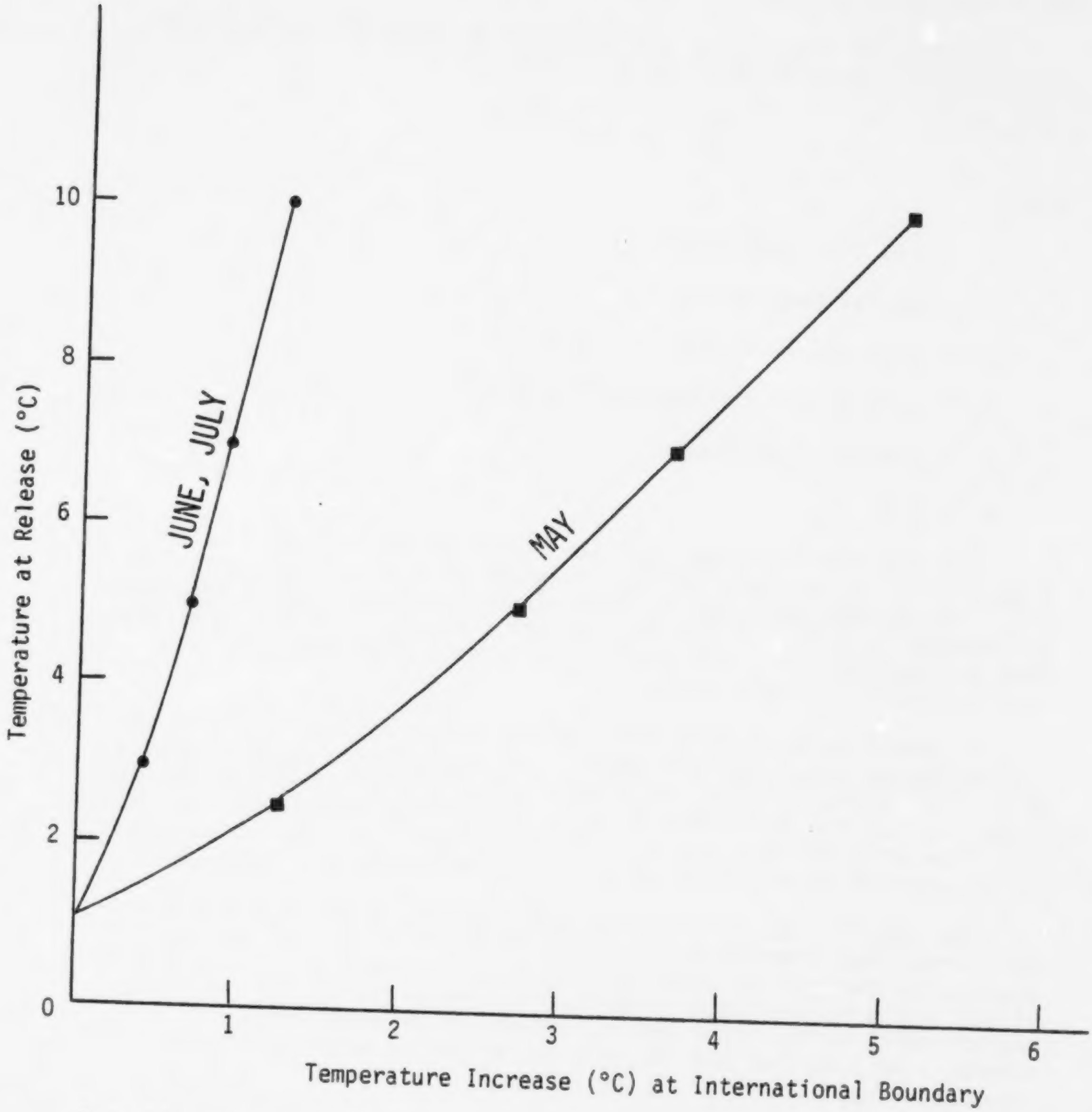
Q = flow

This equation indicates that almost all of the heat will be dissipated prior to the International Boundary at flows of less than 100 cfs. The maximum predicted increase at the boundary is about 4°C, which corresponds to a flow of 250 cfs. Higher flows would result in greater heat dissipation due to increased water surface area resulting from overflow beyond the main channel.

It should be emphasized that the May flow condition (130 cfs) resulting in the predicted 10°C increase at the boundary would generally be a rare occurrence under the proposed apportionment alternatives (see flows for Scenario 29 in Section 5.2). Under most conditions, the East Fork flow would be less than 100 cfs; therefore, the temperature dissipation would be considerably greater than predicted by Spraggs (1977).

The modeling results indicate that the only potential for significant downstream temperature elevations in the U.S. part of the basin would occur during high runoff conditions in the spring. The potential effects would be considerably moderated, however, since the reservoir may not spill during April and May, scheduled releases would generally be less than 100 cfs, and cooler ground water would also enter the river downstream of the reservoir.

Although it is considered unlikely that significant temperature elevations would occur in the U.S. part of the basin, it is an important consideration due to the occurrence of gamefish spawning activities during high flow conditions. Eggs and larvae may be especially susceptible to temperature changes. Therefore, recruitment to walleye and northern pike fisheries is dependent on a given thermal regime during incubation and juvenile development.



Source: Spraggs, 1977

Figure 5.6-2 RIVER HEAT RELEASE SUMMARY

Egg and larvae data collected by Montana Department of Fish and Game (1978) indicate that, during the spring of 1977, walleye and northern pike were probably spawning during the period of mid-April to early May. During the spawning period median daily river temperatures ranged from about 8.9 to 15°C. Daily temperature variations were quite high and ranged from 4.4 to 6.7°C. Larval walleye occurred in the river until mid-May, at which time natural river temperature ranged from 13°C to 21°C.

Studies by Koenst and Smith (1976) on the temperature requirements of young walleye indicate that optimal temperatures for egg incubation range from 9 to 15°C. This temperature range closely corresponds to the observed occurrence of ripe adults and larval walleye during 1977. The young walleye were also quite resistant to temperature changes since they tolerated up to a 10°C increase over a period of 72 hours without adverse effects on survival. The high resistance to rapid temperature fluctuation by young walleye was also demonstrated by Allbaugh and Manz (1964). In the laboratory studies there was also good survival to hatch of walleye eggs incubated at temperatures up to 17.8°C, indicating that relatively small increases in natural river temperature during the spawning season would not adversely affect survival.

The optimal temperature for growth of juvenile walleye was about 22°C (Koenst and Smith, 1976). The upper lethal temperature ranged from 27.2 to 31.7°C as acclimation temperature increased from 7.8 to 26°C. These data indicate that small elevations in ambient river temperature (<3°C) during the juvenile rearing period would also not be detrimental to walleye production. Conversely, it could be potentially beneficial since ambient river temperature during much of May are actually sub-optimal for walleye growth. This is an important consideration since Johnson (1961) found that cold weather during the incubation period may actually be an important limiting factor in determining walleye year-class strength.

Based on available data for young northern pike (Hokanson, et al., 1973), it appears that their temperature tolerances would also not be exceeded by small temperature elevations (<3°C) in downstream areas.

Pike larvae are apparently more sensitive than walleye to rapid temperature changes. However, in field studies Franklin and Smith (1963) found good survival when temperature changes did not exceed 0.7°C/hour.

Furthermore, the upper lethal thresholds (96-hour) for both northern pike and walleye are about 32°C. Since the maximum natural river temperatures are generally about 26.7°C, limited heating (2.8°C) of the river during summer would not exceed the upper limits for gamefish survival.

In summary, mathematical predictions indicate that the downstream temperature elevations due to power plant operation on the Poplar River are a function of:

- number of units
- flow in East Fork

For the two-unit operation (600 MW) the maximum predicted temperature elevation at the boundary during expected spring and summer flows would be less than 1°C. Moreover, during low flows all excess heat would be dissipated prior to the International Boundary. Even under situations of high flow (>130 cfs) the maximum increase at the border would be only about 5°C, and this would decrease rapidly in the East Fork. Therefore, even under the extreme situations (i.e., two-units and high flow) the natural stream temperatures would probably be reached within the East Fork. The available information on the thermal requirements of the two major game fish present in the Poplar River indicates that there would be no adverse impacts due to thermal releases at the reservoir.

5.6.3.2 Effects of Dissolved Solids Increases

Increased total dissolved solids (TDS) levels in freshwaters may be potentially toxic to aquatic life. Tolerance of fishes to increased TDS is highly variable according to species; however, it is generally assumed that TDS concentrations above 5,000 to 10,000 mg/ℓ would generally represent adverse conditions for survival of most freshwater organisms.

It should be emphasized that most freshwater species, especially those inhabiting the Northern Great Plains waters, can tolerate a relatively wide range of TDS concentrations. This is necessary due to the high seasonal variability encountered in many surface water bodies. For example, in the Poplar River, natural TDS concentrations may range from <150 mg/ℓ during high runoff, to over 1000 mg/ℓ during low flow conditions.

In general, the early life stages of fish (i.e., eggs and larvae) are more sensitive to increases in TDS than adults of the same species. Limited data are available on the salinity tolerances of eggs of the two major species of Poplar River gamefish: walleye and northern pike. Peterka (1972) reports that eggs of both species displayed good hatching success in waters with a conductivity of 1300 μmhos. Based on the conductivity - TDS relationship of Poplar River waters at 25°C, this would represent a TDS concentration of about 860 mg/ℓ. As the conductivity was increased to 4000 μmhos (TDS ≈ 2640 mg/ℓ). There was no hatch of walleye eggs and very poor hatch of northern pike. The studies of Petarka (1972) also indicated that fathead minnows (a forage fish in the Poplar River) experience no adverse effects on growth and reproduction at TDS concentrations up to 7000 mg/ℓ.

The water quality modeling results indicate that the highest potential for increases in TDS concentrations resulting from flow apportionment will occur in the Upper East Fork (see Section 5.3.3). With more than two units (1985 and 2000 level of development) the April TDS concentrations in the entire East Fork will be at levels where spawning of walleye and northern pike may be impaired in one year out of every ten (i.e., 90 percent concentration is exceeded). During 90 percent of the spawning seasons the egg tolerance limits should not be exceeded in the East Fork. In all other parts of the U.S. basin, TDS concentrations during April should be below the tolerance levels for successful hatch of gamefish eggs. This results from dilution by lower salinity waters from the West and Middle Forks.

The only condition which results in TDS concentrations exceeding the limits for maintenance of fish population during the non-spawning season is with four units at the year 2000 level of development. In such cases relatively high TDS concentrations (4000-5000 mg/ℓ) would exist in the East Fork during low flow months in the fall and winter. Although such concentrations would probably be toxic to gamefish, the more important limiting factor under Scenario 32 would be the low flow in the lower East Fork (see Sections 5.6.4).

5.6.3.3 Effects of Dissolved Oxygen Changes

Adequate dissolved oxygen is essential for the maintenance of fish populations. This is especially true for gamefish species such as those existing in the Poplar River, which are generally less tolerant of low oxygen levels than "rough" or forage species. There are two main conditions in which dissolved oxygen may be limiting factors for the production of stream fish populations:

1) During the spawning period eggs and larvae may be susceptible to low oxygen levels, especially in species which deposit eggs in the bottom substrate.

2) In areas where surface waters freeze during the winter, low dissolved oxygen conditions may exist, especially in shallow waters at low flow rates.

Based on recent Quality Criteria for Water (EPA, 1976), a minimum dissolved oxygen concentration of 5 mg/ℓ is recommended for the maintenance of gamefish populations. Based on available water quality data, it appears that dissolved oxygen levels in the Poplar River are well above minimum values for gamefish protection during the period of April through November. Even in the upper reaches of the East and West Forks, the dissolved oxygen always exceeded 86 percent saturation. Moreover, these high levels were measured after closure of the dam on the East Fork; therefore, during ice-free conditions no adverse impacts of apportionment flows on dissolved oxygen concentrations are expected to occur.

Dissolved oxygen levels also appear to be sufficient for successful spawning and early development of walleye and northern pike. Oseid and Smith (1971) indicate that the lowest dissolved oxygen concentration for optimal hatching of walleye eggs is 5-6 mg/ℓ. Moreover, a relatively high survival to hatch was observed at dissolved oxygen concentrations of only 2 mg/ℓ. Hatching time was extended, however, and the larvae were smaller at hatching when incubated at 2 mg/ℓ.

Siefert, et al. (1973) found similar results for northern pike eggs and larvae. Dissolved oxygen concentrations of about 5 mg/ℓ were adequate for hatching and survival to the feeding stage. Pike eggs may be more sensitive to continuous lower oxygen concentrations since survival was considerably reduced at a level of 3.4 mg/ℓ. However, pike larvae are apparently able to tolerate short exposures to low dissolved oxygen concentrations. Peterka and Kent (1976) found no reductions in survival of embryos, yolk-sac larvae and larvae maintained for eight hours at dissolved oxygen concentrations of 0.6, 2.0 and 4.0 mg/ℓ, respectively.

Since April dissolved oxygen concentrations in the East Fork after dam closure (since October, 1975) are generally above 5 mg/ℓ, no impacts on fish spawning due to changes in dissolved oxygen levels are anticipated. This conclusion is based on the observed high spawning-period oxygen concentrations under spring flow conditions on the East Fork which are more severe (in regard to flow and oxygen availability) than would be expected under the apportionment agreements. This results primarily from the additional scheduled releases which would add a minimum of 1 cfs to the natural flow resulting from groundwater accretion and surface runoff.

During the period of normal ice cover on the Poplar River, low dissolved oxygen may be an important limiting factor in fish survival. In February-March, 1977, Stewart (1978) observed large numbers of dead walleye, suckers and carp on the East Fork. In late February, dissolved oxygen concentrations as low as 0.1 mg/ℓ were recorded under the ice. Moreover, in some locations there was no water below the ice or the ice depth exceeded 4.5 feet. This lack of available under-ice habitat and low oxygen levels was apparently the cause of the fish kills. Similarly low oxygen levels were observed on the West Fork and, in conjunction with the low summer flows, may explain the lack of gamefish in that part of the basin.

Based on the aforementioned considerations and the historical occurrence of very low flows during January and February, it appears that during years of average or low flows the apportionment of flows and resultant continuous scheduled releases (1 or 2 cfs) will have a potential beneficial effect on fish winter habitat. As indicated in Section 5.2, the flows on the Upper East Fork at both 10 percent and 50 percent frequency will be greater than the corresponding historical flows.

Oxygen concentrations in the East Fork during the previous winter (1976-77) (Stewart, 1978) appear to be satisfactory for fish survival (e.g., >4 mg/ℓ). The average winter flows in 1976-77 (1.7-2.3 cfs) were similar to the median winter flows under development Scenarios 28 through 32.

There are also no anticipated adverse impacts on winter fish habitat in the Middle Fork due to the apportionment. During January and February there is historically little flow at the International Boundary of the Middle Fork or its major tributary, Coal Creek. Therefore, during the winter most of the flow in the Lower Middle Fork has occurred in the U.S. part of the basin below the confluence of Coal Creek. This is true under historical conditions and under Scenarios

28 through 30 (i.e., up to three units at 1985 water use). Scenarios 31 and 32 (3 and 4 units at 2000 water use) include a reservoir on the Middle Fork and median (50 percent) or low (10 percent) winter flows would actually be larger than historical flows in the Lower Middle Fork.

In summary, the apportionment schedule which results in the maintenance of stable winter flows in the East Fork will not adversely impact fish survival in winter and should have a beneficial effect in preventing the occurrence of fish kills during low-flow years.

5.6.3.4 Bioaccumulation of Metals

Aquatic organisms may accumulate some trace metals and organic compounds in their tissues at levels considerably higher than ambient concentrations in the water. Therefore, it is important to evaluate the potential for toxic chemical contamination in aquatic organisms such as gamefish which are utilized as human food.

The Montana Department of Fish, Wildlife & Parks (Stewart, 1980) has recently reported concentrations of mercury in fish muscle tissue from the Poplar River (Table 5.6-6). Those analyses indicated mean mercury concentrations in walleye flesh of about 0.5 mg/wet kg for the East, Middle and West Forks. Maximum values for walleye flesh ranged from 0.8 to 0.9 mg/wet kg. The data for northern pike were much more limited (only three fish tested); however, the values ranged from 0.12 to 0.49 mg/wet kg.

None of the reported mercury concentrations exceed the current FDA "action level" of 1.0 mg/wet kg. However, it should be emphasized that the previous FDA value (prior to 1979) was 0.5 mg/wet kg, a value exceeded by 44 percent of the gamefish analyzed by Stewart (1980).

These data indicate that there is a significant accumulation of mercury in fishes in the Poplar River. Although current FDA action levels are not exceeded by the data, the observed mercury levels indicate that excessive consumption (e.g., more than 1-2 meals per week) of gamefish from the Poplar River should be avoided.

Stewart (1980) states that the reasons for the relatively high mercury concentrations are unknown. Based on the fish tissue concentrations and the water quality data, the contamination appears to be present in all three forks of the Poplar River. The contamination is, therefore, apparently unrelated to the reservoir or power plant construction on the East Fork since walleye and northern pike are sedentary with little observed migration among river sections.

The data of Stewart (1980) indicate, however, the need to carefully monitor mercury and other trace metals in Poplar River biota.

Table 5.6-6 Mercury Content of Fish Muscle Tissue from the Poplar River (Adapted from Stewart, 1980)

Sample Location	Species	No. of Samples	Mean mg/wet kg	Range mg/wet kg
East Fork	Walleye	9	0.45	0.32 - 0.80
	Northern pike	1	0.12	-
Middle Fork	Walleye	10	0.52	0.17 - 0.86
	Northern pike	1	0.42	-
West Fork	Walleye	10	0.52	0.25 - 0.90
	Northern pike	1	0.49	-

The power plant represents a potential source of additional mercury contamination through combustion emissions. Although the analyses performed in section 5.6.2.2 do not indicate a significant enrichment of surface waters due to mercury emissions, the potential for further mercury contamination should be fully investigated since mercury is poorly scavenged by stack gas cleaning methods and its toxicity and potential for bioaccumulation is quite high.

5.6.3.5 Other Constituents

Maximum concentrations of boron up to 20 mg/ℓ could occur in the Poplar River under the apportionment agreement. No impacts on local fish and wildlife are predicted, however, due to the relatively low toxicity of this constituent to animal life. Toxic concentrations to fish are over 1000 times the osmotic predicted concentrations.

Turbidity and suspended solids measurements on the Poplar River indicate that this constituent is not limiting to fish production. Even during extreme high flow conditions the suspended solids are within short-term tolerance ranges. Any effect of power plant development on the East Fork would probably be evidenced as reduced suspended solids loading due to settling in Cookson Reservoir. Therefore, no adverse impacts of development would be predicted.

5.6.4 Impacts of Flow Modifications on Fish and Wildlife

5.6.4.1 Wildlife and Furbearers

Several species of mammals and birds are directly dependent on the aquatic habitat provided by the Poplar River. The two main groups which have a potential for impact from flow modifications are furbearers and waterfowl. Both of these groups require specific aquatic habitat characteristics which may be modified by variations in the amount of water available in the river basin.

During the period from 1977 to 1978 the number of observations of beaver and raccoon in the Poplar River drainage increased slightly. At the same time, the observations of muskrat decreased, while the numbers of mink remained unchanged (DeSimone, 1979). It is generally believed that beaver, muskrat and mink populations have declined during the last 30 years primarily as a result of intensified agriculture and land use practices in the area. It is not anticipated that the proposed action will have an adverse impact on furbearers, since they are not directly dependent upon the magnitude of peak flows.

Inability to maintain existing channel morphology in the upper nine miles of the East Fork due to reduced flows may result in encroachment of emergent macrophytes and a concomitant loss in waterfowl production. Recent studies (DeSimone, 1978) have shown that both waterfowl breeding pair density and production were greater in this portion of the East Fork than on similar areas studied on the Middle Fork, Main River, West Fork, Coal Creek and Butte Creek. While it was concluded that existing submergent and emergent macrophyte growth provided brood cover and was responsible, in part, for the greater brood production in the upper portion of the East Fork (DeSimone, 1979), substantial increases in emergent growth would result in the loss of brood habitat by restricting access to the preferred rearing grounds for surface-feeding species of ducks. It has been shown that a greater than 50 percent areal coverage of emergents on a water body renders these areas unsuitable for duck production (Evans and Black, 1956; Stoudt, 1971; and Whitman, 1976).

In an assessment of the effects of altered flow regimes of the Poplar River, Bahls (1979) stated that flow reductions with two 300 MW units and the proposed apportionment will result in an expansion of the macrophyte community within the system. It was concluded that macrophyte growth within and along the main channel will be most dramatic in the East Fork and may result in 50 percent coverage during the life of the project. The results of an aerial survey of emergent vegetation in several segments of the East Fork Poplar River during July 1979 (DeSimone, 1980) indicated that at least in the area adjacent to the International Boundary one section is approaching 50 percent coverage, while emergent coverage in three other sections ranged from 5.8 to 21.6 percent. However, additional releases specified under the recommended apportionment were not made. Based on the relationship between areal coverage of emergents and waterfowl production presented above additional encroachment in the uppermost reaches of the East Fork will result in a reduction in waterfowl production. Progressive encroachment in the upper nine miles of the East Fork Poplar River resulting in greater than 50 percent areal coverage would result in the loss of approximately 70-80 breeding pairs of ducks and the production of between 300 and 400 ducks annually (DeSimone, 1979). However, simultaneous increases in macrophyte growth in the lower East Fork and Main Poplar River, where abundances of emergents are substantially less than the upper East Fork, could lead to an increase in waterfowl production in these areas and the supplanting of the breeding areas to the north.

5.6.4.2 Fish

The fish populations of the Poplar River are susceptible to habitat alterations resulting from changes in river flow rate. The two major areas of potential impact are:

- Changes in spawning habitat
- Reduction in overwintering habitat

The impacts of flow modifications resulting from apportionment on the winter survival of fish during ice cover conditions are related primarily to the low dissolved oxygen concentrations occurring under low flow conditions in January and February. These impacts are discussed in the water quality section (5.6.3.3).

The main emphasis of this discussion will involve consideration of the flow impacts on spawning habitat for the two major game fish species in the Poplar River: walleye and northern pike. Although the magnitude of flows during non-spawning seasons may also be potentially limiting to game fish production, no adverse impacts of apportionment are expected due to the continued observed occurrence of gamefish (Stewart, 1978) during low flow years such as 1976-77. In such cases measured flows throughout the basin were less than those predicted under the most likely apportionment alternative (VI). Therefore, subsequent impact discussions will be concerned with three main aspects of fish spawning habitat:

1) Maintenance of normal channel morphology
2) Inundation of shoreline vegetation
3) Prevention of siltation

Both northern pike and walleye normally spawn during April in the Poplar River. Although their spawning seasons coincide, they require quite different spawning habitats. Pike deposit adhesive eggs among vegetation in shallow water (<15 inches deep). The eggs hatch in about 2 weeks. Walleye spawn over gravel bottoms in pool tails or riffles (depth usually less than 1.5 feet). Their adhesive eggs settle into the gravel and also hatch in about two weeks.

Walleye are an important game fish in the Poplar River and their continued existence in a prairie stream such as the Poplar River is dependent upon the maintenance of the existing channel morphology consisting of alternating riffles and pools with clean gravel substrate during the spring. Alteration of the morphology of the Poplar River to that of a more typical prairie stream (e.g., uniform gradient, soft bottom) would result in a loss of walleye production. Therefore, it is important to consider the flow regimes required to maintain the current degraded channel.

The hydraulics of the Poplar River are complex. The bed characteristics and meandering channel form make velocities at any transect extremely non-uniform. The abruptness with which flood peaks occur make velocity computation by steady-state hydraulics equations inexact at high flows. However, these are the important flows from the standpoint of maintaining fish habitats in certain portions of the river.

Therefore the actual numerical estimates made in this section to provide a flow and sediment characterization of the East Fork may be considerably in error. However, the numbers do reveal some general relationships such that conclusions can be drawn concerning impacts of flow on fish.

In order to determine if the Poplar River can maintain the degraded channel appropriate for spawning, two questions must be answered. They are:

- What flows produce the tractive forces required to suspend sediments, and
- What duration of the critical flow is necessary to scour the sediments.

Flow uniformity in the channel must first be assumed. This will necessarily underestimate the scouring potential over the riffle areas and overestimate in pool areas. If pools occur in bends of the river, radial acceleration may keep the scouring rates competitive with those in riffle areas.

Brown (1978) conducted a study to determine minimum flow rates for maintenance of fish habitats. In the investigations he collected the particle size data shown in Table 5.6-7. The data are broken down into riffle and pool areas. In general, velocities are lower in pools and finer sediments tend to collect in those areas. To maintain the spawning habitat of game fish on the East Fork, it is necessary to scour the size fractions from approximately the medium sands to the colloidal clays. The velocities required to pick up and transport these particles range from about .52 to 1.04 feet/second. (Longwell, et al., 1969).

The approach to finding the critical flow required on the East Fork included the use of the Manning formula. This equation,

$$V = \frac{1.49}{n} R^{2/3} S^{1/2}$$

says that the average stream velocity (V) is proportional to the stream hydraulic radius (R) and the energy slope (S) and inversely proportional to channel roughness (n). Since the critical velocity (1.04 fps) is known, the equation can be rearranged to calculate R. The roughness coefficient (n) was taken from Schwab, et al., (1966) and has a range of 0.45 to 0.6 from streams like the Poplar. S was found by dividing the difference in elevation of the USGS stream gauge at the International Border and the gauge near Scobey on the East Fork by the total estimated distance in river miles between the two locations. The value of S used was 0.00011 ft/ft. Using these values yielded a hydraulic radius R and, assuming a rectangular channel, a new flow depth was calculated as

Table 5.6-7

BED MATERIAL SIZE DISTRIBUTION

		Particle Diameter						
Sample Location	Pool(P) Riffle(R)	D_5[a] (mm)	D_{16} (mm)	D_{35} (mm)	D_{50} (mm)	D_{65} (mm)	D_{84} (mm)	D_{95} (mm)
East Fork								
2.5 miles below Inter. Border	P	0.058	0.095	0.11	0.15	0.18	0.25	0.4
	R	0.6	4.0	12.5	21	31	39	45
Cromwell Slab	P	0.34	1.6	7.6	12.5	21	46	57
	R	2.7	10.25	20	36.5	52	73	84
USGS gage near Scobey	P	0.27	1.0	4.8	9.1	16.5	31	49
	R	0.5	1.8	8.5	14	22	39	49
Middle Fork								
McCarty Crossing near Int. Border	P	1.7	8	19	33	45	63	80
	R	2.7	11	21	33.5	39	49	58
Hagfeldt Slab	P	0.21	0.37	6.6	21	39	56	62
	R	0.92	8.3	18	26	45	54	58
Ofstedal Slab	P	0.18	0.255	0.30	0.345	0.44	0.79	1.20
	R	4.7	10.5	19.5	28	37	68	75
West Fork								
South of Peerless	P	0.35	4.3	10.0	15.5	20.5	39.5	54
	R	4.2	10.5	25.5	48	68	79	86
Susag Farm	P	1.4	10.0	30	40	51	66	68
	R	0.32	1.8	7.6	14	32	56	68
Main Stem	P	0.062	0.099	0.135	0.165	0.21	0.33	0.45
	R	0.31	1.4	8.0	15	22	41	48
Crowley Slab	P	0.54	0.086	0.128	0.196	0.31	0.38	0.45
	R	0.30	1.6	10.0	17	24	47	52

Source: Brown, 1978

[a] D_5 means that 5 percent of the particles have a diameter less than the value given.

$$\text{depth} = \frac{Rw}{w-2R}$$

where w is the width of the stream (from the Brown (1978) data). Knowing the new depth and channel width, the cross-sectional area can be calculated. The critical flow required to flush sediments from the fish habitats was computed by continuity ($Q = AV$) to be about 715 cfs. The flow required to overtop the main channel and begin inundation of the shoreline vegetation areas is somewhere between 220 and 330 cfs according to similar calculations. This range of values is supported by the report of Saskmont Engineering (1976) which indicated that a 250 cfs flow would escape the main channel. Therefore at flows which would provide the required scouring velocities the pike spawning habitats would be inundated.

Calculating the duration of the required 700 cfs scouring flow is a more difficult problem. The first assumption that was made in this solution was that the reservoir is a 100 percent effective sediment trap for waters spilling from the upper East Poplar across the International Boundary. Secondly, it is assumed that sediment loadings to the river (excepting the within channel bank erosion) come only from cultivated agricultural land.

Using the universal soil loss equation, the annual sediment loads from cropland to the East Fork can be obtained. The equation is:

$$A = RKLSCP$$

where A is the annual sediment loss in tons/acre
R is the rainfall erosivity factor
K is the soil erodibility factor
LS is the slope-length factor
C is the crop factor, and
P is the practice factor.

The parameters were estimated from tabulations and figures in Stewart (1975). The parameter values are given below.

R = 25
K = .30 (for a sandy clay to silt loam soil)
LS = .20 (slope length 1000 ft, .05 percent slope)
C = .23 (spring wheat) and 0.02 for alfalfa
P = .80 (fall seeded grain, low slope)

Using these parameters the gross erosion is about 0.26 tons/acre. Zison, et al. (1977) has presented the relationship developed by McElroy to determine the sediment delivery ratio. Using the drainage density given for the East Fork and the proper soil type, this ratio is determined to be 0.12, yielding a net delivery to the stream of 0.03 tons/acre. The contributing area to the portion of the East Fork from the

International Boundary to the USGS gauge near Scobey is approximately 188 mi^2. Of that, about 74 percent is under cultivation, or about 89,000 acres. This indicates an annual sediment loading in the U.S. portion of the East Poplar of 2670 tons. This, of course, assumed that loadings from uncultivated areas are negligible and that no loads are added in between the reservoir and the U.S. boundary.

To estimate the scour at the critical flow rate, sediment concentration and flow data were taken from USGS records for the East Fork at the International Boundary. The suspended sediment data were converted to mass flux data and plotted versus flow rate. This plot is shown in Figure 5.6-3. A log-log least squares regression gave the best fit line shown in the figure. The equation for sediment flux in grams/seconds given flow in cubic feet/second is:

$$\text{Flux} = 1.16\ (\text{Flow})^{0.97}$$

Substituting 715 cfs into the above, the sediment flux is calculated to be 680 g/sec. This represents the amount of suspended sediment that would move past a point in the river in one second at that flow. If the assumptions are made that the only sediment in suspension comes from overland flow loading and that sediment must be transported through the entire length of the reach, then the time required to flush the East Fork would be 41 days. Realistically, the sediment probably does not need to be moved entirely through the system in order to cleanse critical areas. The spawning habitat in riffles is probably maintained due to the movement of sediments off riffles into more sluggish areas of the stream. These areas are usually where point bars are building up on the inside of bends. Therefore, the 41 days is a nominal upper limit value.

According to Brown (1979) the average distance between areas of severe bank cutting and hence the distance between corresponding sluggish areas on the inside of the turns is about 2,000 feet. If sediments are only required to move this distance, the duration of the 700 cfs flow would necessarily be only about 6 hrs. Very likely, the time required for scouring is between these limits. For instance, the clays may move entirely through the system while coarse sands may be picked up and deposited 2000 feet downstream. Fine sands might travel several miles and then come out of suspension.

The sediment loadings to the East Fork appear to be quite small. The U.S. East Fork from the International Border to the USGS gauge at Scobey is approximately 100 feet wide during high flow on the average. Sediment with voids weighs about 165 pounds per cubic foot. Using this information, the mean annual depth increase of sediment on the stream bed can be estimated. This depth is 0.0007 ft/year. At this rate, 120 years would be required to accumulate a one-inch depth uniformly over the East Fork (assuming bank cutting is a negligible source). If siltation occurs as a result of reduced flows, it will likely be a very slow process.

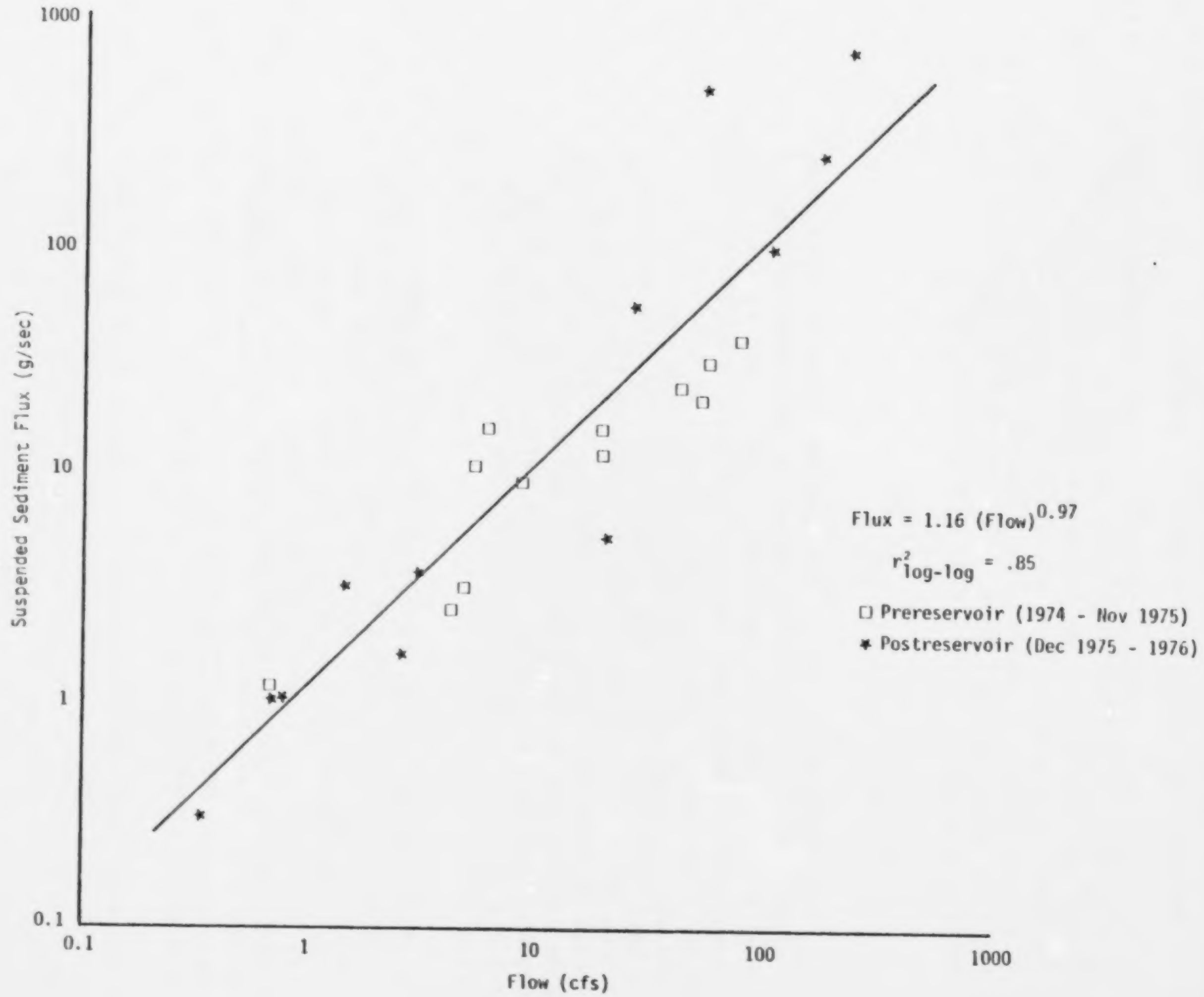


Figure 5.6-3 SEDIMENT FLUX VERSUS FLOW AT THE INTERNATIONAL BOUNDARY EAST FORK POPLAR RIVER

Analysis of historical records indicates that on the upper East Fork the peak discharge with a return period of 2 years is 948 cfs. Although it would occur normally for only a short period (e.g., <2 days), peak flows of this magnitude have obviously been sufficient to maintain adequate spawning substrate for walleye.

Since the water quantity modeling results are based on total monthly flows, it is difficult to predict the exact effects of apportionment on the magnitude or duration of peak flows which may occur for short periods only. However, it is reasonable to assume that peak flows on the East Fork are considerably reduced when compared with pre-impoundment conditions. The scheduled releases under the apportionment would be insufficient to affect significant scouring. The analysis of spills (Draper, 1979) indicates that with more than two units in operation and flow apportionment, there may be a gradual change in channel morphology, especially in the East Fork. These changes would eventually result in an adverse impact on the availability of walleye spawning habitat in the form of riffles with clean gravel bottoms.

Several factors suggest, however, that the adverse impacts on walleye spawning habitat may not be manifested for some time after initiation of power plant operation and flow apportionment:

- Low sedimentation rate. Reservoir construction has actually reduced sediment load in the East Fork due to sedimentation in the reservoir and reduction in bank erosion due to lower peak flows.
- Continued spawning on East Fork after closure of Morrison Dam. Flows on the East Fork during the last two spawning seasons (1977 and 1978) have been approximately equal to, or less than, median flows predicted to occur with one power plant unit in operation. Although poor spawning occurred in 1977, a good year class of gamefish was apparently produced in the East Fork in 1978.

The spawning success of pike and walleye (Stewart, 1978; Stewart, 1979) during the last two years will be examined in further detail in order to predict effects of stable flows during April on gamefish spawning success. These data are important since they were collected after closure of Morrison Dam and two quite different flow regimes were represented: an extremely low flow period in April of 1977, and a higher flow in April of 1978 which was, however, still below average for the historical period.

During both years walleye and northern pike in spawning condition were found in all three Forks and in the main Poplar River. In the low flow year of 1977, there was an apparent failure of the walleye year class on the East Fork. In April of 1978, there were many more larvae of both walleye and pike collected, indicating increased spawning success when compared with 1977. The East Fork station referred to as Cromwell had the highest mean density of walleye eggs per sample when compared to all other 1978 sampling stations. Moreover, in 1978 numbers of young-of-the-year walleye per mile on the East Fork increased to about 13 times the densities measured in 1977. Over the entire river basin 1978 densities of young-of-the-year walleye were approximately double the 1977 densities. There was also apparently a successful 1978 year-class formation of northern pike on the East Fork as evidenced by the occurrence of ripe spawners and young-of-the year fish. It must be emphasized, however, that there are no actual baseline evaluations of normal fish spawning in the Poplar River. Therefore. although 1978 was a good year for year class formation, it may have actually been less than the potential production under optimal flow conditions.

All of these data indicate that the April, 1977, flows on the East Fork were not sufficient for successful gamefish spawning, while the flow regimes in 1978 were adequate for the formation of a good year class. The conclusion regarding the relative success of the 1978 East Fork spawning of walleye is further substantiated because there probably was a reduced spawning population due to winterkill. The large mortality of walleye observed in that area during February and March was due to low dissolved oxygen concentrations below the ice cover (Stewart, 1978). Thus, the spawning success might have been even greater with a normal size spawning population.

Pike typically spawn among submerged vegetation during high flow or flood conditions. Several studies indicate that pike prefer submerged terrestrial vegetation such as native grasses, mowed hay or wheat stubble for spawning substrate (McCarraher and Thomas, 1972; Forney, 1968). Others have found, however, high utilization of submerged plants such as *Myriophyllum* (Frost and Kipling, 1967) or emergents such as sedges or rushes (Franklin and Smith, 1963). Apparently, flooding beyond the primary channel is not necessary for successful pike spawning in the Poplar River. This is evidenced by the occurrence of a peak flow of only 80 cfs during April of 1978. In order to overtop the main channel in the East Fork, a flow in excess of about 200 cfs would be required.

Examination of the flow data presented in Table 5.6-8 reveals that during 1977 the East Fork experienced very low flow conditions. The East Fork April flows at the border and Scobey stations were considerably less than (∿50 percent) natural or historical 10 percent frequency flows (Table 5.6-9). Moreover, peak April flows reached only 11 cfs. This condition probably resulted from a combination of an extreme low runoff year and the blockage of flow at Morrison Dam.

The 1977 Middle Fork flows at the border were relatively higher since there is no impoundment on that Fork. The April flows were about 20 percent higher than the 10 percent frequency flow on an historical basis.

The April, 1978, East Fork flows (average and peak) at the International Boundary were approximately equal to the 1977 measurements. However, flow accretion in the U.S. East Fork sub-basin resulted in higher peak and average flows in the lower East Fork near Scobey than occcurred in 1977.

Table 5.6-8

COMPARISON OF 1977-1979 SPRING FLOWS AT SELECTED POPLAR RIVER STATIONS

		Flow (cfs) at Stations							
		East Fork at Border		East Fork at Scobey		Middle Fork at Border		Main River at Poplar	
		Peak	Average	Peak	Average	Peak	Average	Peak	Average
1977	MARCH	5.8	2.6	22	8.3	15	9.5	168	112
	APRIL	2.9	2.4	11	6.6	15	11.1	210	122
	MAY	58	13	164	17.9	82	12.4	42	31.3
1978	MARCH	6.2	3.6	220	69.7	829	225	4610	1163
	APRIL	3.3	2.7	80	24.5	709	75.4	4630	640
	MAY	3.9	3.0	10	6.1	56	25.6	205	150
1979	APRIL	270.0	143.0	-	-	1620	325.3	-	-
	MAY	139.0	43.9	-	-	155.0	59.7	-	-

Table 5.6-9

PREDICTED AVERAGE APRIL FLOWS (cfs)
IN THE EAST FORK POPLAR RIVER

		PERCENTILE		
	Scenario	90	50	10
Station 1 East Fork at Border	1	308	28.6	7.7
	2	301	28.6	7.1
	28	270	11.4	1.0
	29	249	2	1.0
	32	63.3	2.2	1.0
Station 3 East Fork near Scobey	1	492	48.0	13.7
	2	--	48.4	--
	28	437	23.0	4.3
	29	398	20.4	2.2
	32	221	17.7	0.04

These comparisons indicate that average spawning-period flows of 2.4 to 6.6 cfs are not adequate for successful game fish spawning in the Poplar River. However, as the average flow in the same river reach increased to 2.7 to 24.5 cfs, a good year class was formed. During the successful spawning period, peak flows ranged from 3.3 to 80 cfs, while the poor spawning period was characterized by peak flows of 2.9 to 11 cfs.

Comparison of 1977-78 East Fork flows with predicted flows under apportionment reveals that the measured 1978 average April flows were only slightly higher at Stations 1 and 3 than the predicted flows under scenario 29 (i.e., 2 units at 1985 water use)(Table 5.6-9). Therefore, with up to two 300 MW units, the walleye and pike spawning on the East Fork should be approximately equal to the 1978 level of success with a return period of 2 years. However, in one out of ten years with one or more units in operation, the April East Fork flow would average only 0 to 4.3 cfs, resulting in severe adverse effects on game fish reproduction. Based on the observed spawning-flow relationships in the East Fork, it is expected that the flow apportionment has a lower potential for adverse impact on fish spawning in the main river and middle forks. However, the apportionment will also affect flows in the main river and long-term effects on stream morphology may occur.

Recent fish data collected by Stewart (1980) provide further evidence for the influence of streamflow on spawning success of walleye and northern pike in the Poplar River. In 1979, there was above average runoff in combination with spring releases from Cookson Reservoir. The 1979 average April flow at the East Fork Border station was 143.0 cfs, compared to 1977 and 1978 flows of 2.7 and 2.4 cfs, respectively. The higher 1979 flows resulted in the formation of strong year classes as evidenced by high densities of young-of-the-year walleye and northern pike in the East and Middle Forks.

The relationship between spring flow and year class recruitment for the period 1977-1979 is diagrammed in Figure 5.6-4. Abundances of young-of-the-year walleye and northern pike at downstream stations show a positive correlation with mean April flow near the border in both the East and Middle Forks. Coefficients of determination (r^2) for the walleye and northern pike were 0.84 and 0.73, respectively. Although these data were from two different river sub-sections, and some data are estimates due to low collection numbers, they do provide an indication of the strong relationship between flow rate and year class recruitment for both species. Flow appears to be a stronger predictor for young walleye survival than for northern pike as evidenced by the corresponding r^2 values. In addition, the slope of the walleye data (82.29) is considerably higher than that for northern pike (35.23). Therefore, as mean April transboundary flow increases from 10 to 100 cfs the predicted density of young-of the year walleye increases by 190/mi, while predicted northern pike density increases only about 80/mi.

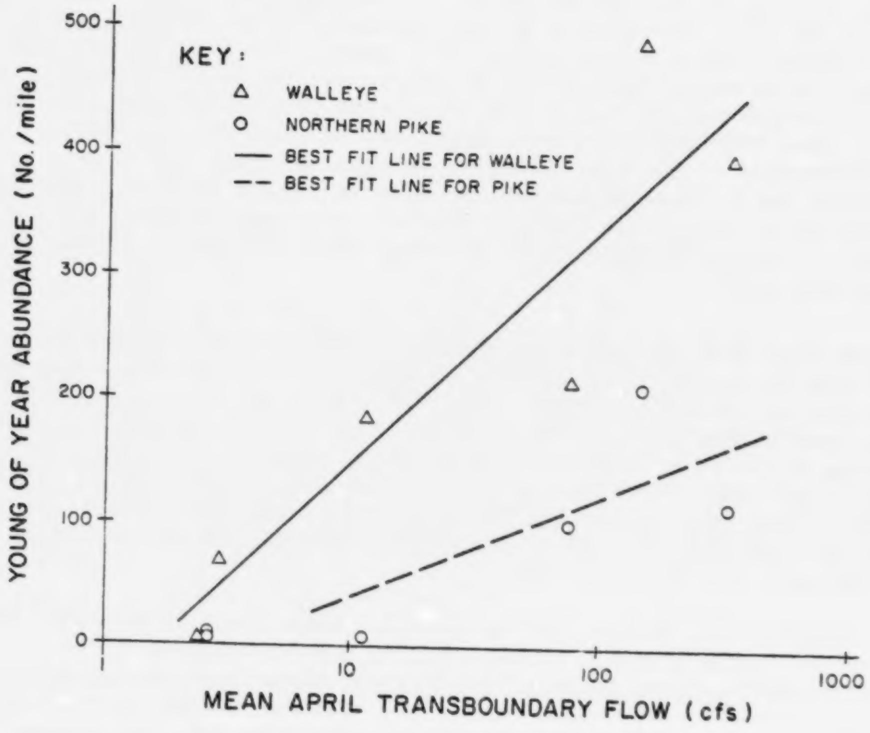


Figure 5.6-4 RELATIONSHIP BETWEEN FLOW AND YEAR-CLASS FORMATION OF GAME FISH IN THE EAST AND MIDDLE FORKS OF THE POPLAR RIVER

The flow-spawning success relationship presented in Figure 5.6-4 may be used to provide a quantitative estimate of impacts on fish populations due to the power plant operation and apportionment. Based on natural and historical April transboundary flows (scenarios 1 and 2) the mean young-of-the-year class strength for walleye and northern pike is about 235/mi and 77/mi, respectively (Table 5.6-10).

Operation of one 300 MW unit (scenario 28) would result in a 32 percent reduction in the young-of-the-year walleye density during a median flow year. With two 300 MW units and the 1985 level of development (scenario 29) the predicted impact would be a greater than 90 percent reduction in young-of-the-year walleye densities. The corresponding reductions in northern pike densities for scenarios 28 and 29 are 42 percent and greater than 87 percent, respectively.

Several important points should be emphasized regarding the flow related impacts on fish:

- The predicted impacts are for the lower portions of the East Fork. The impacts on the already marginal fish habitat in the upper East Fork will probably be greater.
- The impacts are predicted for median flow conditions under the indicated apportionments. During low flow years (e.g., tenth percentile) the impacts under apportionment would be considerably greater, probably resulting in complete failure of the year class in the East Fork.
- The predicted impacts are based on the maintenance of currently existing channel morphology and substrate type. Flow related impacts on such physical conditions would compound the overall biological impacts.
- Impacts on young-of-the-year gamefish are not necessarily manifested directly as changes in the size of adult fish populations. Density dependent mechanisms may act to ameliorate the initial poor year class formation, resulting in less effect on subsequent older age groups.

It should also be emphasized that the preceding flow-recruitment relationships are for transboundary flows only and were conducted primarily to illustrate the apparent influence of instream flow on one measure of fish production; i.e., young-of-the-year class abundance. As mean April transboundary flows are reduced below 10 cfs, the relative decline in young-of-the-year abundance is high due to the logarithmic relationship described in Figure 5.6-4. This is illustrated by the relatively large difference between the 1977 and 1978 young-of-the-year walleye abundances (3 vs. 69) when the respective transboundary flows were only 2.4 and 2.7 cfs.

Table 5.6-10

PREDICTED RELATIVE IMPACT OF FLOW APPORTIONMENT ON YOUNG-OF-THE-YEAR CLASS STRENGTH OF POPLAR RIVER GAME FISH

Scenario	No. of Power Plants	Mean April Flow (cfs)	Predicted 0+ Density* (No./Mile)		Percent Reduction	
			Walleye	N. Pike	Walleye	N. Pike
1-2, Natural-Historical	0	28.6	235	77	0	0
28 Apportionment, 1975 use	1	11.4	160	45	32	42
29 Apportionment, 1985 use	2	2	<20	<10	>90	>87

---

*0+ means young-of-the-year class.

However, as previously indicated, there was considerable flow accrual in the East Fork during 1978, resulting in a mean 1978 flow at Scobey of 80 cfs compared to only 11 cfs in 1977. Moreover, the egg abundance data of Montana Fish & Game also indicate the much higher spawning success in 1978. Although walleye and egg production was relatively high in 1978, the young-of-the-year abundance was still considerably lower than that observed in the high-flow year of 1979. This relationship suggests that flow-related effects on fish continue to operate after egg deposition and that low spring flows may reduce egg hatching or larval survival even though egg production is high.

Mitigation of flow related impacts on Poplar River fish populations would require maintenance of specified instream flows by controlled reservoir releases. Two types of flow regimes would be required:

- Maintenance of flow required to provide spawning habitat for gamefish during April-May.
- Maintenance of peak flows to preserve channel morphology.

Based on the fish data collected by Stewart (1980), it appears that a transboundary flow of at least 10 cfs during April and May would insure the successful spawning and rearing of both walleye and northern pike in the mid and lower East Fork. Although some recruitment would occur at average flows between 2 and 10 cfs, the long-term effects of such flow regimes would most likely be a decline in the East Fork gamefish populations. It should be emphasized, however, that the production of young gamefish would increase at flows of 10 to 200 cfs. Therefore, a spawning period flow of 10 cfs should be considered as a minimum for maintaining gamefish spawning and rearing at a level that would sustain gamefish recruitment in parts of the East Fork.

Based on the flow modeling results, the operation of one 300 MW unit with 1975 water use (scenario 28) would result in a median April transboundary flow of 11.4 cfs. Under such flow conditions there would be successful gamefish recruitment in the East Fork in average or high flow years, if channel morphology were maintained. However, during low flow years (e.g., 10 percentile, Table 5.6-9) there would be insufficient flow under the apportionment schedule for successful gamefish spawning. It is during such low-flow years that flow augmentation by increased April-May reservoir releases would provide mitigation against adverse impacts on fish populations.

The previous analyses in this section indicate that a peak flow of about 715 cfs would be required to provide sufficient scouring of fine material to maintain the present riffle-pool configurations. The required duration of the peak flow is unknown; however, it would most likely be in the range of 0.25 days to 41 days. Since flows of this magnitude have not been historically maintained for a monthly period, the required duration of peak flows is probably nearer the lower limit of the indicated range. In order to provide optimal mitigation, the peak flow release should be provided shortly before the spawning period in April-May.

The Biological Resources Committee (BRC) of the International Poplar River Water Quality Board (IPRWQB, IJC, 1979) has provided estimates of water requirements in the East Fork necessary to meet various biological objectives. The objectives for maintenance of gamefish spawning and rearing habitat are 15 cfs in April and 10 cfs in May at the International Boundary. The BRC's April recommendation is higher than the estimate of 10 cfs contained in this document. The committee's recommended requirement for maintenance of channel integrity is an 18-day release, consisting of at least 123 cfs for 16 days and a peak of 700 cfs for two days within the period. The BRC's peak flow recommendation is the same as the flow requirements presented in this document; however, no duration of flow was contained herein. Based on our evaluation of the overall range required (0.25 to 41 days), the BRC estimate would be of comparable magnitude.

An evaluation by Draper (1979) of historical spring peak flows on the East Fork during a 46-year period indicates that a two-day peak flow greater than 700 cfs has occurred in 30 percent of the years. Peak spring flows exceeding 700 cfs for a single day have historically occurred in 43 percent of the years. These data provide an estimate of the baseline frequency of peak flows necessary to maintain current channel morphometry.

The analyses of Draper, 1979, and computations conducted as part of this impact analysis indicate that with up to two 300 MW units in operation a two-day reservoir release of about 700 cfs could be attained at approximately the same annual frequency as has occurred historically for the last 46 years. However, operation of the reservoir with four 300 MW units would result in a much lower frequency of reservoir spills exceeding 700 cfs. With four-unit operation such spills would be available during a maximum annual frequency of 10 percent. The actual potential for such spills would probably be considerably less than 1 year out of 10, however.

These analyses indicate that with proper reservoir operation a channel maintenance flow could be released from Cookson Reservoir at annual frequencies approximately those during the last 46 years. Such releases should be sufficient to maintain the riffle-pool configuration necessary for gamefish spawning and survival.

Montana Department of Fish and Game (1979) has recently published recommendations for instream flows to protect walleye and northern pike in the Poplar River. The April and May recommended flows are the same as the BRC's estimates, i.e., 15.0 and 10.0 cfs, respectively. Table 5.6-11 presents the recommended flows for the remainder of the year for both upper and lower reaches of the East Fork.

Flow recommendations (Montana Department of Fish and Game, 1979) were based on the previously discussed spawning flow requirements and channel maintenance flows. In addition, flows for the remainder of the year were based on the observations that game fish seem to be maintained at flows less than mean flows. The months of January and February are exceptions in that the recommended flows are higher than mean flows due to the potential for under-ice mortalities at low flows.

Table 5.6-11

RECOMMENDED INSTREAM FLOWS FOR THE EAST FORK OF THE POPLAR RIVER

Month	East Fork Flow (cfs)	
	Upper Reach*	Lower Reach†
January	2.0	3.0
February	2.0	3.0
March	5.0	5.0
April	15.0	15.0
May	10.0	10.0
June	5.0	5.0
July	3.0	4.0
August	3.0	4.0
September	3.0	4.0
October	3.0	4.0
November	2.0	3.0
December	2.0	3.0

---

*Boundary to Highway 13 bridge

†Highway 13 bridge to mouth

The overall effects of Apportionment VI on Poplar River game fish will be primarily associated with changes in spawning period flows and channel forming flows. The effects of modified instream flows during the remainder of the year are much more difficult to quantify. Although predicted flows under apportionment are less than recommended instream flows under low flow conditions, the effects on fish are unknown. A beneficial effect of apportionment may exist, however, during January-February of low flow years. Under such conditions, natural (predevelopment) flows may reach very low levels (see Figure 5.2-16). Under the apportionment schedule, flow would be maintained at 1.0 cfs, only slightly less than existing conditions (1975 use and reservoir) which would tend to mitigate against under-ice mortality of gamefish. Therefore, the 1.0 cfs release would tend to mitigate against winter gamefish mortalities although it is lower than the Montana Department of Fish and Game recommendation of 2.0 cfs for the upper East Fork. Actual flows would be higher due to ground water.

The evaluation of flow related impacts on fish has been oriented towards walleye and northern pike, the two major game species in the Poplar River. Modifications in flow may effect other species as well; however, impact generalizations are difficult to develop due to the variety of fish species present and the lack of specific life history information on non-game species. Some species may be adversely affected by reduced flow, while others may benefit from conditions under flow apportionment.

Modified flow regimes can also be expected to influence the community composition of benthic macroinvertebrates in the Poplar River. Previous studies have indicated that many of the Ephemeroptera and Trichoptera of the Poplar River are dependent upon flowing water habitat. The long-term changes in stream morphometry predicted under apportionment will result in a reduction of stream dependent taxa and an increase in macroinvertebrate fauna adapted to ponds or slow moving streams. The overall effects are difficult to assess due to the complex interrelationships of potentially lowered densities due to the loss of riffle habitat and the potential increases due to stimulation of macrophyte production.

6. REFERENCES

Accu-Labs Research, Inc. 1978. 11485 West 48th Avenue, Wheat Ridge, Colorado. Letter sent to Terry Thoem, EPA, concerning results of Poplar River ash sample analysis.

Agarwala, S.C., N.K. Mehrotra and B.K. Sinha. 1964. Influence of exchangeable sodium of the growth and mineral composition of plants. Journal of the Indian Soc. of Soil Sci. 12:7-23.

Allbaugh, C.A., and J.V. Manz. 1964. Preliminary study of the effects of temperature fluctuations on developing walleye eggs and fry. Prog. Fish Cult. 16:175-180.

American Hospital Association Guide to the Health Care Field, 1977 Edition.

American Medical Association. 1976. Physician distribution and medical licensure in the United States.

American Public Health Association (APHA). 1976. Standard Methods.

Asana, R.D. and V.R. Kale. 1965. A study of salt tolerance of four varieties of wheat. Indian Journal of Plant Physiology. VIII:5-22.

Ayers, A.D., J.W. Broun and C.H. Wadleigh. 1952. Salt tolerance of barley and wheat in soil plots receiving several salinization regimes. Agronomy Journal 44:307-310.

Bahls, Loren L. 1977. Spring and summer phycoperiphyton of the Poplar River system, Montana: A pre-energy development, baseline floristic survey of a transboundary river. Prepared for Water Quality Bureau, Montana Department of Health and Environmental Sciences.

Bahls, L.L. 1979. International Joint Commission - International Poplar River Water Quality Board. Biol. Res. Com. Final Report. Aquatic Plant Section. 133 p.

Bains, et al. 1970. Relative salt tolerance of barley varieties. Indian Journal of Agronomy. XV:356-358.

Bellrose, F.C. 1976. Ducks, Geese, and Swans of North America. Wildlife Management Institute.

Bennett, S.H., A.C. Hill, A. Soleimani and W.H. Edwards. 1975. Acute effects of combination of sulphur dioxide and nitrogen dioxide on plants. Environmental Pollution 9:127-132.

Bernstein, L. and L.E. Francois. 1973. Leaching requirement studies: sensitivity of alfalfa to salinity of irrigation and drainage waters. Soil Science Soc. Am. Proc. 37:931-943.

Bernstein, L., L.E. Francois, and C.A. Clark. 1974. Interactive effects of salinity and fertility on yields of grains and vegetables. Agronomy Journal 66:412-420.

Bernstein, L. and G.A. Pearson. 1956. Influence of exchangeable sodium on the yield and chemical composition of plants: I. green beans, garden beets, clover and alfalfa. Soil Science Soc. Am. Pro. 82:247-258.

Biggar, J.W. and M. Fireman. 1960. Boron adsorption and release by soils. Soil Science Soc. Am. Proc. 24:115-119.

Bingham, F.T., A.L. Page, N.T. Coleman, K. Flach. 1971. Boron adsorption characteristics of selected amorphous soils from Mexico and Hawaii. Soil Science Soc. Am. Proc. 35:356-550.

Blood, D.A., G.G. Anweiler and J. Polson. 1976. Wildlife Impact Study - Poplar River Thermal Power Project--Final Report. Prepared for the Saskatchewan Power Corporation, August, 1976.

Bloom, and Botz. 1975. Water Quality Inventory and Management Plan. Lower Missouri River Basin, Montana. pgs 20-21 (Biological conditions).

Bower, C.A. 1961. Cation-exchange equilibria in soils affected by sodium salts. Soil Science Soc. Am. Proc. 32-35.

Bower, C.A. and L.V. Wilcox. 1965. Precipitation and solution of calcium carbonate in irrigation operations. Soil Science Soc. Am. Proc. 29:93-94.

Bower, C.A., G. Ogata and J.M. Tucker. 1968. Sodium hazard of irrigation waters as influenced by leaching fraction and by precipitation or solution of calcium carbonate. Soil Science Soc. Am. Proc. 106:29-34.

Brady, N.C. 1974. The Nature and Properties of Soils. Mac Millian Publishing Company, Inc., New York.

Braun, D. 1978. Vegetation chemistry, In: Gelhaus, J.W., Background Air Quality Studies of the Poplar River Area of Northeastern Montana, 1977. Montana Department of Health and Environmental Sciences, Air Quality Bureau.

Breeder, C.M. and D.E. Rosen. 1966. Modes of Reproduction in Fishes. Natural History Press, Garden City, New York.

Briggs, G.A. 1972. Discussion on chimney plumes in neutral and stable surroundings. Atmospheric Environment 6:507-610.

Briggs, G.A. 1969. Plume Rise. U.S. Atomic Energy Commission critical review series, TID-25075, National Technical Information Service, Springfield, Virginia 22151.

Briggs, G.A. 1971. Some recent analyses of plume rise observations, pp. 1029-1032 in Proceedings of the Second International Clean Air Congress, edited by H.M. Englund and W.T. Berry, Academic Press, New York.

Broomfield, A.R. 1972. Absorption of atmospheric sulphur by mustard growth in a glass house. J. Agric. Sci. 78:343-344.

Brown, L. September 11, 1978. Unpublished Report, Montana Department of Natural Resources and Conservation, Helena, Montana.

Brown, L. 1979. Personal Communication, Hydrologist, Montana Department of Natural Resources and Conservation, Helena, Montana. February 8, 1979.

Bureau of Indian Affairs. August, 1974. Profile of the Montana Native American.

Cairnes, Saskatchewan Power Company, telephone conversation, May, 1979.

Chalmers, J.E., et al. 1979. An empirical model of spatial interaction in sparsely populated regions, prepared for presentation at the Twenty-Fourth North American Meeting, Regional Science Association in November.

Chang, C.W. 1961. Effects of saline irrigation water and exchangeable sodium on soil properties and growth of alfalfa. Soil Science Soc. Am. Proc. 91:29-37.

Chang, C.W. and H.E. Dregne. 1955. Effect of exchangeable sodium on soil properties and on growth and cation content of alfalfa and cotton. Soil Science Soc. Am. Proc. 19:29-35.

Chauhan, R.P.S. and S.L. Powar. 1978. Tolerance of wheat and pea to boron in irrigation water. Plant and Soil 50:145-149.

Colwell, W.E. and R.W. Cummings. 1944. Chemical and Biological Studies on Aqueous Solution of Boric Acid and of Calcium, Sodium and Potassium Metaborates. Soil Sciences Soc. Am. Proc. 57:37-49.

Cowling, D.W., L.H.P. Jones and D.R. Lockyer. 1973. Increased yield through correcting of sulfur deficiency in ryegrass exposed to sulfur dioxide. Nature 243:479-480.

DeSimone, R. 1978. Poplar River wildlife study, Quarterly Progress Reports (February, June, September). Montana Department of Fish and Game, Ecological Services Division, sponsored by U.S. Environmental Protection Agency.

DeSimone, R. 1979. Poplar River waterfowl study: Final Report. Montana Department of Fish and Game, sponsored by U.S. Environmental Protection Agency.

DeSimone, R. 1980. Poplar River waterfowl study progress report. Montana Department of Fish and Game, sponsored by U.S. Environmental Protection Agency.

Dodd, J.L., W.K. Laurenroth, R.K. Heitschmidt and J.W. Leetham. 1978. First-year Effects of Controlled Sulfur Dioxide Fumigation on a Mixed-grass Prairie Ecosystem. In: The Bioenvironmental Impact of a Coal-fired Power Plant, E.M Preston and R.A. Lewis, eds. Third Interim Report, EPA-600/3-78-021, U.S. Environmental Protection Agency, Corvallis, Oregon. pp. 345-375.

Dreisinger, B.R. and P.C. McGovern. 1970. Monitoring atmospheric sulfur dioxide and correlating its effect on crops and forests in the Sudbury area. In: Proceedings of the conference on the Impact of Air Pollution on vegetation. Toronto, Ontario, Canada.

Duggan, J.S. February, 1979. Poplar River study, Poplar River, Montana, August, 1978. Lockheed Electronics Company, Inc., for Office of Research and Development, U.S. Environmental Protection Agency, Las Vegas, Nevada.

Dvorak, A.J., et al. 1977. The environmental effects of using coal for generating electricity. NUREG-0252. Prepared for U.S. Nuclear Regulatory Commission by Argonne National Laboratory, Argonne, Illinois.

Eaton, F.M. 1974. Deficiency, toxicity, and accumulation of boron in plants. Journal of Agricultural Research 69:237-277.

Eaton, F.M. and L.V. Wilcox. 1939. Behavior of Boron in Soils. USDA Technical Bulletin 696. 58 pp.

Edinger, J.E. and E.M. Buchak. 1975. A hydrodynamic, two-dimensional reservoir model: The computational basis. J.E. Edinger Associated, Inc., Wayne, Pennsylvania.

Elgabaly, M.M. 1955. Specific effects of adsorbed ions on plant growth: I. effect of different combinations of calcium, magnesium and sodium on barley seedlings. Soil Science Soc. Am. Pro. 80:235-248.

Evans, C.D. and K.E. Black. 1956. Duck production studies on the prairie potholes of South Dakota. U.S. Fish and Wildlife Service Spec. Sci. Rept., Wildl. No. 32. 59 pp.

Evans, R.G., W.R. Walker, G.V. Skogerboe and S.W. Smith. 1978. Evaluation of irrigation methods for salinity control in Grand Valley. EPA-600/2-78-161. U.S. Environmental Protection Agency, Ada, Oklahoma.

Faller, N. 1970. Effects of atmospheric SO_2 on plants. Sulphur Inst. J. 6:5-7.

Faller, N. 1971. Plant nutrient sulphur: SO_2 versus SO_4. Sulphur Inst. J. 7:5-6.

Feltis, R.D. 1978. Water resources of shallow aquifers in the Upper Poplar River Basin, Northeastern Montana. U.S. Geological Survey, Montana Bureau of Mines and Geology with U.S. Environmental Protection Agency.

Forney, J.L. 1968. Production of young Northern Pike *(Esox lucius)* in a regulated marsh. New York Fish Game J. 15(2):143-154.

Fowler, D. 1978. Dry deposition of SO_2 on agricultural crops. Atmospheric Environ. 12:369-373.

Fox, R.H. 1968. The effect of calcium and pH on boron uptake from high concentrations of boron by cotton and alfalfa. Soil Science Soc. Am. Proc. 106:435-439.

Franklin, D.R. and L.L. Smith, Jr. 1963. Early life history of the northern pike, *Esox lucius L.*, with special reference to the factors influencing the numerical strength of year classes. Trans. Amer. Fish. Soc. 92(2):91-110.

Frost, W.E. and C. Kipling. 1967. A study of reproduction, early life, weight-length relationships and growth rate of pike, *Esox lucius L.* in Windermerl, J. Animal Ecology 36(3):651-693.

Garland, J.A. 1978. Dry and wet removal of sulphur from the atmosphere. Atmospheric Environ. 12:349-362.

Gelhaus, J.W. and M.D. Roach (Eds). 1979. Issue paper by the Scientific and Engineering Advisory Panel on Poplar River Air Quality. Air Quality Bureau, Montana Dept. Health and Environ. Sci. 31 p.

Gelhaus, J.W. and M. Machler. 1978. Background air quality studies of Poplar River area of northeastern Montana, 1977. Part II, meteorology, Montana Department of Health and Environmental Sciences, Air Quality Bureau.

Gelhaus, J.W., M.G. Machler, S.Z. Schwartz and M.D. Roach. 1979. Background air quality studies of Poplar River area of northeastern Montana, 1978. Montana Department of Health and Environmental Sciences, Air Quality Bureau.

Gelhaus, J. W. 1980. Air Quality Impact Analysis of the Poplar River Power Plants. 29 p.

Griffin, R. A. and R.G. Burau. 1974. Kinetic and equilibrium studies of boron desorption from soil. Soil Science Soc. Am. Proc. 38:892-897.

Griffith, D.W., et al. 1978. Enterprise costs for fallow, winter wheat, spring wheat, barley, recrop safflower in Roosevelt County. Bulletin 1179, Cooperative Extension Service, Montana State University, Bozeman, Montana.

Hadas, A. and J. Hagin. 1972. Boron adsorption by soils as influenced by potassium. Soil Sciences Soc. Am. Proc. 113:189-193.

Hanks, R.J., T.E. Sullivan and V.E. Hunsaker. 1977. Corn and alfalfa production as influenced by irrigation and salinity. Soil Science Soc. Am. Proc. 41:606-609.

Hargreaves, G.H. 1973. Estimation of potential and crop evapotranspiration. American Society of Agricultural Engineers. Paper No. 73-4537.

Hassan, N.A.K., et al. 1970. Influence of soil salinity on production of dry matter, uptake and distribution of nutrients in barley and corn: I. Barley. Agronomy Journal 62:43-45.

Hatcher, J.T. and L.A. Bower. 1958. Equilibria and dynamics of boron adsorption by soils. Soil Science Soc. Am. Proc. 85:319-323.

Hill, A.C., S. Hill, C. Lamb and T.W. Barrett. 1974. Sensitivity of native desert vegetation to SO_2 and $SO_2 + NO_2$. Journal of Air Pollution Control Association 24.

Hokanson, K.E.F., J.H. McCormick and B.R. Jones. 1973. Temperature requirements of northern pike, *Esox lucius*, eggs and larvae. Trans. Amer. Fish. Soc. 102: (In press).

Holzworth, G.C. 1972. Mixing heights, wind speeds, and potential for urban air pollution throughout the contiguous United States, Environmental Protection Agency, 118 pp.

Horpestad, A. 1978. Analyses of irrigated soils from the Poplar River Basin. Water Quality Bureau, Environmental Sciences Division, Montana Department of Health and Environmental Sciences. 26 pp.

Hosler, C.R. 1961. Low-level inversion frequency in the contiguous United States, monthly weather review. pp. 319-339.

Howard, A.D. 1960. Cenozoic History of northeastern Montana and northwestern North Dakota with emphasis on the Pleistocene, U.S. Geological Survey Prof. Paper 326, 107 pp.

Ingvalson, R.D., J.D. Rhoades and A.L. Page. 1976. Correlation of alfalfa yield with various index of salinity. Soil Science Soc. Am. Proc. 122:145-153.

International Joint Commission. 1978. Water apportionment in the Poplar River Basin. An IJC report to the Governments of Canada and the United States.

International Joint Commission. 1979. International Poplar River Water Quality Study. Final Report and Appendixes.

International Joint Commission. 1979. Transcripts of Public Hearings on the Study of the International Poplar River Water Quality Board held at Scobey, Montana on the 10th day of September, 1979 and at Coronach, Saskatchewan on the 11th day of September, 1979. 274 pp. and 290 pp.

International Joint Commission. 1981. Water Quality in the Poplar River Basin. 268 p.

Johnson, F.H. 1961. Walleye egg survival during incubation on several types of bottom in Lake Winnibigoshish, Minnesota, and connecting waters. Trans. Amer. Fish. Soc. 90:312-322.

Kamphorst, A. and G.H. Bolt. 1976. Saline and Sodic Soils in Bolt, G.H. and M.G.M. Bruggenwert, ed., Soil Chemistry A. Basic Elements. New York: Elsevier Scientific Publishing Company 171-191.

Karp, R.W. 1978. Poplar River model interim report. Water Quality Bureau, Environmental Sciences Division, Department of Health and Environmental Sciences. 54 pp.

Klages, M. 1976. Water quality requirements for irrigation in the Poplar River Valley. Montana Health and Environmental Sciences, Helena. 8 pp.

Klarich, Duane, A. 1978. Surface water site inventory of the Poplar River drainage and preliminary considerations of potential water quality impacts from the coal-fired, power generation development near Coronach, Saskatchewan. U.S. Environmental Protection Agency, Grant No. R008115.

Koenst, W.M. and L.L. Smith, Jr. 1976. Thermal requirements of the early life history stages of walleye, *Stizostedion vitreum vitreum*, and sauger, *Stizostedion canadense*. J. Fish. Res. Board, Canada. Vol. 33.

Latimer, Douglas A. 1980. Power plant impacts on visibility in the west: siting and emissions control implications. J. Air Poll. Cont. Assoc. 30:142-146.

Likens, G.E., F.H. Bormann, N.M. Johnson and R.S. Pierce. 1967. Ecol. 48:772.

Lizon, S.N. 1978. Effects of air-borne sulfur pollutants on plants. In: J.O. Nriagu, Ed. Sulfur in the environment. Part II. ecological impacts. Wiley-Interscience. New York, pp. 109-162.

Longwell, C.R., R.F. Flint and J.E. Sanders. 1969. Physical Geology. John Wiley and Sons, Inc., New York.

Lucas, Merle Source. August, 1974. Profile of the Montana native American. Urban management consultants.

Luft, L.D. (No Date Given) Feasibility--Side roll irrigation system, dryland wheat to irrigated wheat, unpublished paper. Cooperative Extension Service, Montana State University, Bozeman, Montana.

Luft, L.D. March 1979. The economics of sprinkler irrigation. Cooperative Extension Service, Montana State University, Bozeman, Montana.

Luft, L.D. and D.W. Griffith. July, 1978. Costs of owning and operating eight hay harvesting, handling and feeding systems. Bulletin 1149, Cooperative Extension Service, Montana State University, Bozeman, Montana.

Mathew, E. May, 1979. Senior resident engineer, Saskatchewan Power Company, telephone conversation.

McCarraher, D.B. and R.E. Thomas. 1972. Ecological significance of vegetation to Northern Pike *(Esox lucius)* spawning. Trans. Am. Fish. Soc. 101(3):560-563.

McKee, J.E. and H.W. Wolf, Eds. 1963. Water quality criteria. Publication 3-A, California State Water Resources Board, Sacramento, California.

Mehrotra, C.L. and B.R. Gangwar. 1964. Studies on salt and alkali tolerance of some important agricultural crops in Uttar Pradesh. J. Indian Soc. Soil Sci. 12:75-84.

Mesich, F.G. and H.L. Taylor. 1976. Levels of trace elements in the ambient air at selected locations in the Northern Great Plains. NTIS PB-265863. 35 pp.

Montana Department of Agriculture. 1976. Montana agricultural statistics.

Montana Department of Community Affairs. 1974. Human resources situation report for action for Eastern Montana (AEM).

Montana Department of Community Affairs. July, 1978. Montana population projections 1980-2000. summary. Research and Information Systems Division.

Montana Department of Community Affairs. 1978. Division of Research and Information Systems. Profiles for Daniels and Roosevelt counties.

Montana Department of Community Affairs. 1979. Division of Research and Information Systems, County profiles. Unpublished update, May.

Montana Department of Fish and Game. 1976. A summary of fish population investigations in the Poplar River drainage. July 1, 1975 through March 31, 1976.

Montana Department of Fish and Game. 1978. Lower Missouri River Basin investigation. Planning inventory game. Ecological Services Division, job progress report. July 1, 1977 through June 30, 1978.

Montana Department of Fish and Game. 1979. Instream flow evaluation for selected streams in the upper Missouri River Basin. Department Report. Helena, Montana. 250 p.

Montana Department of Health and Environmental Studies, Water quality standards. MAC 16-2.14(10)-514480.

Montana Department of Health and Environmental Sciences. 1978. Mining and mineral fuel development in the Montana statewide 208 study area implications to water quality.

Montana Department of Labor and Industry. 1977. Montana Employment and Labor Force, Employment Security Division, Vol. 7, No. 7, July, and Vol. 8, No. 3, March.

Montana Department of Natural Resources and Conservation. 1975. Water use in Montana. Inventory series report No. 13, April, 1975.

Montana Department of Natural Resources and Conservation. 1978. Final report on water uses in the Poplar River Basin.

Montana Department of Natural Resources and Conservation. 1978. Determination of minimum instream flows, sediment discharge, and stream channel formation related to the balance of natural maintenance and preservation of fishery/wildlife habitat and manipulation of the Poplar River by man.

Montana Energy Advisory Council. 1976. Coal development information packet (updated in 1977).

Morrison-Maierle, Inc. and Fort Peck Sioux and Assiniboine Tribes. 1978. Poplar River existing and future uses, Fort Peck Indian Reservation, Montana, for Environmental Protection Agency, Denver, Colorado. 17 p.

Mukammal, E.I. 1976. Review of present knowledge of plant injury by air pollution. WMO Tech. Note No. 147. World Meteorological Organization, Geneva, Switzerland.

National Academy of Sciences. 1975. Air Quality and Stationary Source Emission Control. Report by the Commission on Natural Resources, National Academy of Sciences, National Academy of Engineering, National Resource Council, U.S. Senate Committee on Public Works, Serial 94-4, U.S. Government Printing Office, Washington, D.C.

National Association of Counties, International City Management Association. 1977. The county year book, profiles of individual counties.

National Ecological Research Laboratory. 1974. The bioenvironmental impact of a coal-fired power plant. Colstrip, Montana. Corvallis, Oregon.

Nelson, H., H.F. Travland, D.W. Anderson, P. Ag., R.E. McAllister, P. Ag. and A.H. Klesse, P. Eng. 1977. The reclamation of mine spoil at Coronach, Saskatchewan.

Noggle, J.C. and H.C. Jones. 1979. Accumulation of atmospheric sulfur by plants and sulfur-supplying capacity of soils. NTIS PB-298 875. 37 p.

Northern Great Plains Resources Program. 1974. Surface resources work group - regional profile discussion draft.

Nyborg, M. 1978. Sulfur pollution and soil. In: J.O. Nriagu, Ed. Sulfur in the environment. Part II: ecological impacts. Wiley-Interscience, New York, pp. 359-390.

Olson, R.V. and K.C. Berger. 1946. Boron fixation as influenced by pH, organic matter content and other factors. Soil Science Soc. Am. Proc. 11:216-220.

Oseid, D.M. and L.L. Smith. 1971. Survival and hatching of walleye eggs at various dissolved oxygen levels. Progressive Fish-Culturist, April.

Parfit, M. 1980. A gathering storm over syn fuels on the big sky range. Smithsonian Magazine - March issue. p. 70-78.

Parizek, R.R. 1964. Geology of the Willow Bunch Lake area (72-H), Saskatchewan. Saskatchewan Research Council, Geology Division, Report No. 4.

Patel, A.S. and N.G. Dastane. 1971. Effect of different soil textures, levels of leaching and salinity on radish and barley. Indian J. Agron., 16:327-33.

Peterka, John. 1972. Effects of saline waters upon survival of fish eggs and larvae and upon the ecology of the fathead minnow in North Dakota. North Dakota Water Resources Research Institute, Fargo, North Dakota.

Peterka, J.J. and J.S. Kent. 1976. Dissolved oxygen, temperature, survival of young at fish spawning sites. U.S. Environmental Protection Agency Report. Environmental Research Laboratory, Duluth. Report No. 600/3-76-113.

Poplar River Task Force. 1976. Joint studies for flow apportionment Poplar River Basin in Saskatchewan and Montana, Appendix C: Probable future use.

Porteen & Associates. 1980. Daniels County Planning Board A Comprehensive Plan 1979-1980. 22 p.

Portelli, R.V. 1975. Meteorological aspects of airborne pollutant dispersion from the proposed Poplar River Thermal Generating Station, Saskatchewan. Atmospheric Environment Service, report ARQT-3-75.

Rhoades, J.D. 1972. Quality of water for irrigation. Soil Science 113:277-284.

Rhoades, J.D., R.D. Ingvalson and J.T. Hatcher. 1970. Laboratory determination of leachable soil boron. Soil Science Soc. Am. Proc. 34:871-875.

Rice, P.M., L.H. Pye, R. Boldi, J. O'Loughlin, P.C. Tourangeau and C.C. Gordon. 1979. The effects of "low level SO_2" exposure on sulfur accumulation and various plant life responses of some major grassland species on the ZAPS sites. In: Bio-environmental impact of a coal-fired power plant. Fourth interim report, Colstrip, Montana. 1978. EPA-600/3-79-044. pp. 494-591.

Sales and Marketing Management magazine, Survey of buying power (1974-1978).

Saskatchewan Environment. 1981. Letter from G. P. Underwood to K. Summers dated April 8, 1981. 5 p.

Saskatchewan Power Corporation. 1977. Poplar River, thermal power project environmental assessment and mine reclamation. Summary report.

Saskatchewan Power Corporation. 1976. Coal and environmental programs: Poplar River coal test burn at B.D.P.S. Unit #1, December 19, 1975 and May 5, 1976.

Saskatchewan Power Corporation. 1978. Poplar River, thermal power project environmental assessment and mine reclamation--supplementary report, water quality and fisheries.

Saskatchewan, Province of. 1981. Regulations under the Air Pollution Control Act. Regulation 211 175 dated 8/26/75.

Saskmont Engineering Company, Ltd. 1978. Poplar River Reservoir, final environmental assessment. Vol. I, January, 1978, for Saskatchewan Power Corporation.

Saskmont Engineering Company, Ltd. 1979. Evaluation of Recirculating Wet Ash Disposal System for Saskatchewan Power Corporation.

Schaefer, J., et al. 1978A. Costs of dryland crop production in Sheridan and Daniels counties. Revised to accompany Bulletin 1133, Cooperative Extension Service, Montana State University, Bozeman, Montana.

Schaefer, J., et al. 1978B. Costs of irrigated crop production in Blaine County. Circular 1146 (revised), Cooperative Extension Service, Montana (July, 1978A).

Schwab, G.O., R.K. Frevert, T.W. Edminister and K.K. Barnes. 1966. Soil and water conservation engineering. John Wiley and Sons, Inc., New York. p. 543.

Scriven, R.A. and B.E.A. Fisher. 1975. The long range transport of airborne material and its removal by deposition and washout. Atmospheric Environ. 9:49-68.

Shourbagy, N.E. and A. Wallace. 1965. Sodium accumulation and sodium responses of five varieties of barley. Agronomy Journal 57:449-450.

Shy, C.M. 1978. Health consequences of human exposure. In: J.O. Nriagu, Ed., Sulfur in the environment. Part II: ecological impacts. Wiley-Interscience, New York. pp. 75-108.

Siefert, R.E., W.A. Spoor, and R.F. Synett. 1973. Effects of reduced oxygen concentrations on northern pike *(Esox lucius)* embryos and larvae. Journal Fish. Res. Board, Canada. 30:849-852.

Singh, S.S. 1964. Boron adsorption equilibrium in soils. Soil Science Soc. Am. Proc. 98:383-387.

Smetana, D.R. 1979. Soil Scientist, Soil Conservation Service, Wolf Point, Montana. Personal Communication.

Sposito, G. and S.V. Mattigod. 1977. On the chemical foundation of the sodium adsorption ratio. Soil Science Soc. Am. Proc. 41:323-329.

Spraggs, L.D. 1977. SRSWQ-Souris River study water quality model. Canadian Water Resources Engineering Corporation Report to Environment. Canada.

Stecher, P.G., Ed. 1968. The Merck Index. Rahway, New Jersey. The Merck and Company, Inc. p. 160.

Stevens, T.H. and T.W. Hazelton. 1976. Sulfur dioxide pollution and crop damage in the Four Corners region: A simulation and analysis. New Mexico State University Agricultural Experimental Station Bulletin No. 647.

Stewart, B.A. 1975. Control of water pollution from cropland Volume I, a manual for guideline development. U.S. Environmental Protection Agency - U.S. Department of Agriculture EPA-600/2-75-026a.

Stewart, B.W. 1978. Poplar River fisheries study progress report. Sponsored by: U.S. Environmental Protection Agency. File EPA 18-6-2-8.

Stewart, B.W. 1979. Poplar River fisheries study progress report. Montana Department of Fish and Game, sponsored by: U.S. Environmental Protection Agency. 19 p.

Stewart, B.W. 1980. Poplar River fisheries study: Final report. Montana Department of Fish and Game, sponsored by: U.S. Environmental Protection Agency.

Stoneberg, Ronald P. August, 1977. Fish and game planning, lower Missouri River - game. July 1, 1976-June 30, 1977, Montana.

Stoudt, J.H. 1971. Ecological factors affecting waterfowl production in the Saskatchewan parklands. Res. publication 99 of the Bureau of Spt. Fish and Wildlife., Washington, D.C. 58 pp.

Sukava, L.F. 1977. Poplar River, a recreation development plan for the East Poplar River Reservoir and Plant. Prepared by the Tourism and Recreation Planning Branch, Department of Tourism and Renewable Resources for the Saskatchewan Power Corporation.

Tanner, C.E. 1977. Landsat land cover study of Poplar River Basin, Montana. Prepared for Environmental Monitoring and Support Laboratory, U.S. Environmental Protection Agency, Contract 68-03-2153.

Thomas, R.E. and D.M. Whiting. 1977. Annual and seasonal precipitation probabilities. EPA-600/2-77-182. U.S. Environmental Protection Agency, Ada, Oklahoma, August.

Tingey, D.T., L. Bard and R.W. Field. 1978. The relative sensitivity of selected plant species to several pollutants singly and in combination. From: The bio-environmental impact of a coal-fired power plant, third interim report: U.S. Environmental Protection Agency, Ecological Research Series.

Torres, C. and F.T. Bingham. 1973. Salt tolerances of Mexican wheat: I. effect of NO_3 and NaCl on mineral nutrition, growth, and grain production of four wheats. Soil Science 37:711-715.

Turner, D. Bruce. 1970. Workbook of atmospheric dispersion estimates, U.S. Department of Health, Education and Welfare, Cincinnati, Ohio.

U.S.D.A. and Montana Department of Agriculture, Montana Agriculture County Statistics, Vol. XVI, 1974 and 1975.

U.S. Department of Agriculture. 1974. Irrigation Guide for Montana. Soil Conservation Service, Bozeman, Montana.

U.S. Department of Commerce, Bureau of the Census, U.S. Census of Housing. 1960. Vol. 1, PT. 28; 1970, First and fourth count summary tape and Montana housing.

U.S. Department of Commerce, Bureau of the Census. 1975. County business patterns, Montana, 1975. (CBP75-28)

U.S. Department of Commerce, Bureau of the Census. 1976. Population estimates: Estimates of the population of Montana counties and metropolitan areas; July 1, 1974 and 1975, (June, 1976).

U.S. Department of Commerce, Bureau of the Census. 1976. Population estimates: Estimates of the population of North Dakota counties and metropolitan areas; July 1, 1974 and 1975, (July, 1976).

U.S. Department of Commerce, Bureau of the Census. 1977. Industry-specific gross output multipliers for BEA economic areas (January, 1977).

U.S. Department of Commerce, Bureau of the Census, current population report, Federal-state cooperative program for population estimates, Series P-26, No. 109, May.

U.S. Department of Commerce, Bureau of the Census, current population reports, population estimates and projections, Series P-25, No. 517, May.

U.S. Department of Commerce, Bureau of the Census, current population reports, Federal-state cooperative program for population estimates, Series P-26, No. 53, February and No. 76-26, July.

U.S. Department of Commerce, Bureau of Economic Analysis, Regional Economic Information System (magnetic tape).

U.S. Department of Commerce. 1968. Climatic Atlas of the United States, Environmental Science Service Administration - Environmental Data Services, June.

U.S. Environmental Protection Agency. 1973a. Effects of sulfur oxides in the atmosphere on vegetation. Revised chapter 5 for air quality criteria for sulfur oxides, EPA-R3-73-030; PB-226 314.

U.S. Environmental Protection Agency. 1975. Water quality criteria. Committee on water quality criteria.

U.S. Environmental Protection Agency. 1976. Quality criteria for water. U.S. Government Printing Office, Washington, D.C.

U.S. Environmental Protection Agency. 1977a. National interim primary drinking water regulations. U.S. Government Printing Office, Washington, D.C.

U.S. Environmental Protection Agency. 1977b. National secondary drinking water regulations. Federal Register, Vol. 42, No. 62.

U.S. Geological Survey. 1968. Mineral and water resources of Montana. U.S. Senate Document No. 98. U.S. Government Printing Office, Washington, D.C.

Vaughan, B.E., et al. 1975. Review of potential impact on health and environmental quality from metals entering the environment as a result of coal utilization. Battelle energy progress report, Pacific Northwest Laboratories - Battelle Memorial Institute, Richland, Washington.

Wahhab, A. 1961. Salt tolerance of various varieties of agricultural crops at the germination stage. In: Salinity Problems in Arid Zones: Proceedings of the Teheran Symposium. p. 185-192.

Walker, W.R., G.V. Skogerboe and R.G. Evans. 1978. Best management practices for salinity control in Grand Valley. EPA-600/2-78-162, July. U.S. Environmental Protection Agency, Ada, Oklahoma.

Werkhoven, C.H.E. 1964. Boron in some saline and nonsaline soils in southeastern Saskatchewan. Soil Science Soc. Am. Proc. 28:542-545.

Whetstone, R.R., W.O. Robinson and H.G. Byers. 1942. Boron distribution in soils and related data. USDA Technical Bulletin 797.

Whitaker, S.H. and E.A. Christiansen. 1972. The Empress Group in southern Saskatchewan, Canadian Journal of Earth Sciences, Vol. 9, No. 4 April, p. 353-360.

Whitman, W.R. 1976. Impoundments for waterfowl. Canada Wildlife Services Occas. Paper No. 22, 22 pp.

Wilhour, R.G., Grady E. Neely, David E. Weber and Louis Grothaus. 1977. Response of selected small grains, native range grasses and alfalfa to sulphur dioxide. Corvallis Environmental Research Laboratory, Corvallis, Oregon.

Wilhour, R.G. and D.E. Weber. 1975. Response of small grains and forages to sulfur dioxide: A literature review. Corvallis Environmental Research Laboratory. Corvallis, Oregon.

Wilhour, R.G., G.E. Neely, D.E. Weber and L.C. Grothaus. 1979. Response of selected small grains, range grasses and alfalfa to sulfur dioxide. In: Bio-environmental impact of a coal-fired power plant. Fourth interim report, Colstrip, Montana, 1978. EPA-600/3-79-044. pp. 592-609.

Yabroff, I.W. and E.M. Dickson. 1979. Coal resources model: An impact assessment tool, draft final report, SRI International, Menlo Park, California (February, 1979).

Zison, S.W., K.F. Haven and W.B. Mills. 1977. Water quality assessment: A screening method for nondesignated 208 areas. EPA-600/9-77-023. U.S. Environmental Protection Agency. August, 1977.

7. Public Comments

The Draft EIS was made available to the public on August 15, 1980. The public comment period was open until October 20, which was 45 days after the notice was published in the Federal Register on September 5. The public hearing on the Draft EIS was held September 23, 1980, at 7:30 PM at the Scobey Parish Center in Scobey, Montana. Testimony was heard from 16 people. The letters and written responses are included in Part A and the excerpts from the public hearing record and the responses are included in Part B. All comments have been addressed by a response in this chapter, a change in the DEIS, or both. A list of commentors is given below.

Part A

Agency	Name
Saskatchewan Environment	R. Carter
Environment Canada	W. Draper
Agriculture Canada	D. Cameron
U.S. Department of the Army	A. Thomsen
U.S. Department of Health & Human Services	T. Moore
U.S. Department of Housing & Urban Development	R. McKinney
U.S. Department of Interior	J. Rathlesberger
Office of Area Director	T. Whitford
U.S. Water & Power Resources Service	J. Marcotte, Jr.
U.S. Geological Survey	C. Geiger
U.S. Soil Conservation Service	V. K. Haderlie
Montana Lieutenant Governor	T. Schwinden
Montana Water Resources Division	-
Three Corners Boundary Association	L. Humbert
Daniels County Health Department	M. Fitz
Missouri River Basin Commission	C. Hanson
District Sanitarian	E. Gustafson
Montana Historical Society	M. Sherfy
Morrison-Maierle, Inc.	M. Watson
-	R. Schneekloth
Fort Peck Indian Tribe	D. Johnson
-	J. R. Sims

Part B

Agency	Name
Montana State Representative	Mr. D. Nathe
Montana Air Quality Bureau	Mr. H. Robbins
Daniels County Commissioner	Mr. B. Tande
-	Dr. J. Sims
-	Mr. M. Gunderson
-	Mr. M. Halverson
Three Corners Boundary Association	Mr. L. Humbert
-	Mr. E. Lund
Northern Plains Resources Council	Mrs. H. Waller
-	Mr. G. Farver
Daniels County Women Involved in Farm Economics	Mrs. A. Danielson
-	Mr. A. Lund
-	Mr. B. Cromwell
-	Mr. J. Wolfe
-	Mr. K. Lee

Saskatchewan
Environment

Saskatchewan

5th flr. 1855 Victoria Ave.
Regina, Canada
S4P 3V5

File P7-4-14

October 16, 1980

ENVIRONMENTAL PROTECTION AGENCY
OCT 23 1980
MONTANA OFFICE

Ivan W. Dodson
Director, Montana Office
Environmental Protection Agency
Federal Building, Drawer 10096
301 South Park
Helena, Mt. 59601
USA

Dear Mr. Dodson:

Draft Environmental Impact Statement
for "Impact of Canadian Power Plant
Development and Flow Apportionment on
the Poplar River Basin"

I would like to express the appreciation of this department in having been provided the opportunity to comment on the above-noted draft environmental impact statement. The Poplar River development is a project which has received much prior study both at the provincial and the international level. We are therefore, particularly interested in your study insofar as it represents the environmental impacts from the American perspective.

The documents provided us were circulated to several departmental personnel having expertise in the various impact areas dealt with in the report. The review that was undertaken was qualitative rather than quantitative. In other words, we did not attempt to duplicate modelling results, for example.

The report evokes a largely favourable reaction from our department. The type and degree of the various impacts are generally well documented and in most respects agree with work done here in Saskatchewan.

Some items, due to their presence in or absence from the report did attract our attention and we offer the following comments for your consideration in the preparation of the final impact statement. The comments are organized under four headings; Project Description, Air Quality, Water Apportionment and Water Quality.

Project Description

1) It is felt that the report would have benefitted substantially from a more detailed project description. In discussing specific impacts the report made reference to various development scenarios. In many cases it was not made clear which scenario was the most probable and which proposals were more remote possibilities. From our point of view, a two unit, 600 MW development is most probable and therefore the impacts from such an installation should receive greater attention than those resulting from a single unit or a four unit project. This could be accomplished if the most likely development scenario was emphasized and other proposals were given secondary status.

It should be made clear that we do not argue with the investigation of the full range of possible impacts. Rather, we feel it important that the reader be able to grasp relatively quickly the most probable consequences of the project implementation.

The Saskatchewan Power Corporation (SPC) would be the best source of information regarding the project.

Air Quality

2) The modelling and interpretive work described in the report is a confirmation of our own previous investigations and opinions.

It may be of value to you to be aware of our control philosophy as it applies to this plant. The Regulations under The Air Pollution Control Act stipulate the following standard for SO_2, for example:

1-hour	450 $\mu g/m^3$
24-hour	150 $\mu g/m^3$
1-year	30 $\mu g/m^3$

The Coronach Power Plant will be controlled to meet this standard. A continuous monitor will be placed in the critical azimuth range of 120° to 170°. Any exceedance of this standard will lead to a requirement of SPC for the appropriate level of emission control.

With respect to the licensing of unit No. 2, a decision with regard to SO_2 emission control will be based on the monitoring of the operation of unit No. 1 and modelling studies of the two unit operation.

Responses to Saskatchewan Environment

1) Sentences have been added to 1st paragraph of Chapter II p 5 stating that present plans call for operation of 2 units (300 MW each). Two additional units could be built in the future and are also considered in the EIS. Present plans for air quality controls and operation of the ash lagoons have been added to this chapter also.

2) Information on air quality standards has been added to Chapter 3 "Alternatives".

Water Apportionment

3) The draft report appears to contain misinterpretations of the recommended apportionment agreement. In the case of the Middle Fork Poplar River, the report evaluates a 60 per cent use of the natural flow in Saskatchewan while the recommended apportionment permits a maximum of 40 per cent use of the natural flow. This is of some concern since such a misinterpretation results in an apparently larger impact on downstream flows than should, in reality, be the case.

4) The several apportionment options studied and the impacts from them are difficult to interpret. Could the results of the studies be simplified in the summary chapters of the report in a more understandable form?

Water Quality

The sections of the report dealing with water quality suffer somewhat because of the numerous options analyzed and the difficulty, as stated earlier, of identifying the most probable water quality impacts as opposed to those having a low probability of occurrence.

5) As you are aware, SPC has made modifications to the originally proposed ash lagoon operation. It will be a sealed, recirculating system with no decant. Our approval of the ash lagoon operation under The Water Resources Management Act prohibits overflow or discharge from the lagoons to Cookson Reservoir or the East Poplar River. Further, if monitoring around the ash lagoons indicates seepage may be greater than five litres per second to Cookson Reservoir or two litres per second to the East Poplar River, SPC will be required to provide this department with mitigation proposals.

Regular and comprehensive monitoring of ground and surface water quality is also a stipulation of the approval.

I hope that the foregoing comments will be seen as being in the spirit of constructive criticism and that they are consequently of value to you. I reiterate to you the overall positive reaction we have to your report.

If we can be of further assistance to you in regard to this matter, feel free to contact me at the above address.

Yours sincerely,

R. L. Carter
Deputy Minister.

Responses to Saskatchewan Environment

3) The summary (p. 1) incorrectly stated that the flow on the Middle Fork would be reduced by 60 percent. The correct value of a 40 percent reduction was used in the modeling studies and analysis of impacts.

4) Table F-2 showing differences in West and Middle Fork flows under the alternative apportionments has been moved from the Appendix to Section 3.2.1. Other changes were made in this section to emphasize effect of the alternatives.

5) Ash lagoon operation as presented here was discussed on p 21 of the draft EIS. Requirements for monitoring and mitigation if seepage exceeds specified limits have been added. A statement has been added to to Section 5.3 to indicate that scenarios 4A and 8A, with the ash lagoon seepage included, represent a worst case and that SPC plans on recirculating the ash lagoon seepage.

		Responses to Environment Canada
14)	6. P. 22, 4th para. The first unit is now ready for start-up and the second is under construction.	Current status of plant is known. Paragraph has been updated.
15)	7. P. 60, last para. The wind rose plots referred to seem to be in Appendix B-1 as opposed to A-8.	Text reference corrected as stated here.
16)	8. P. 72, 2nd and 3rd paras. Does this discussion deal with the highest values in all directions or the areas of highest SO_2 concentrations in the U.S. only? Interim EPA modelling results (IJC Appendix E, p. 5-77) show the highest annual SO_2 concentrations west of the plant between Coronach and Rockglen. The isopleths of annual SO_2 concentrations in Figure 5.1-4 have not been fully completed to the northwest of the plant to show this.	The discussion on p. 72 of the draft EIS deals with the predicted SO_2 concentrations in the U.S. shown in Figure 5.1-5. In general, the EIS deals only with possible impacts in the U.S. The text has been changed to indicate that the SO_2 concentrations referenced in this section are those that occur in the U.S.
17)	9. P. 126, last para. The figure of 30 ac-ft/month of subsurface flow from the ash lagoons to the East Fork seems high. This equates to about 14 L/s whereas the predicted ash lagoon seepage to the river is expected to be less than 2 L/s.	Seepage given here referred to no recirculation case. Sentence has been added to explain planned ash lagoon operation which would have seepage of 2 liters or less.
18)	10. P. 127 to p. 143. The crop yield reduction estimates presented are dealt with in detail in the attached comments by Dr. Cameron of Agriculture Canada. Some additional comments are as follows. (i) The crop yield reduction tables on page 132 to 141 are open to major misinterpretation in the manner they are presented. The tables should contain the expected frequency and actual estimated quantity of crop lost over an extended time period. Presenting only "maximum yield reductions" as a percent makes it difficult to appreciate the extent of crop loss on average or even in the majority of years, since it is a condition that would rarely occur. Also, it should be established whether the crop could have been irrigated in that season without the power development since it would have been a very low run-off year.	The tables in the text are for example purposes only and the conditions under which these yield reductions were evaluated immediately precede each. Complete tables showing all losses evaluated under each scenario are shown in Appendix G. These losses were computed assuming no moisture stress for future or present yields. The quantity issue is not dealt with in the crop effects section. However quantity was considered in the economic evaluations.
19)	(ii) P. 131. The method of developing the regression equations for boron (and correspondingly the curves in Figures G-1.1 to G-1.4 in Appendix G) is highly questionable. It appears that the Eaton and Fox irrigation water boron concentrations have been reduced substantially to account for soil adsorption in obtaining the "equilibrium in soils solution" concentrations	Full expanation given in Appendix G.

.../4

used for deriving these curves. Yet both Eaton and Fox used sand as the soil in their experiments and concluded that they would not expect any significant boron adsorption or fixation. Hence, the soil solution concentrations would have been comparable to the concentrations in the water applied (simulated irrigation water). It is unclear in this document how the boron adsorption capability for sand was determined and applied to the boron concentrations of the water used in the experiments, which ranged up to 25 mg/l and 32 mg/l in the Eaton and Fox experiments respectively. It is probably quite valid to apply a high adsorption factor to the Poplar River basin soils in estimating effects but inappropriate to assume much adsorption in deriving the curves from the experimental data.

20) (iii) P. 139 to p. 141. The percent yield reductions presented in the tables on these pages are based on the ln (EC x SAR) vs percent yield functions in Figures G-1.5 to G-1.8 of Appendix G. It is interesting to note that when these same functions are applied to measured saturation extract data for the basin (Horpestad, 1978), one computes an oat yield reduction as high as 92 percent at one station (sample 109) and 78 percent at another (sample 119). Significant yield losses are also indicated at other stations and for other crops. As a means of validating the functions, it would be appropriate to compare the yields that were actually achieved in the sampling year with the yields predicted by using the functions. In other words how close was actual crop reduction at sampling point 109 to the 92 percent reduction predicted by applying the function. Presenting this information would help qualify the accuracy of the yield reductions estimated on pages 139 to 141.

21) (iv) P. 140, Table 5.3-4. The source data used for this table should be re-examined. The 1.6 mg/l boron value for the Fort Peck Reservation soils, at least, is highly questionable. The source document (Horpestad, 1978) indicates that these were hot water soluble measurements and that 6 of the 11 samples were of insufficient quantity to conduct boron analyses. For these samples boron was listed as "non-detectable". Yet it appears that all 11 values were used in the averaging process, assuming the 6 "insufficient sample" values had 0 mg/l boron.

Response to Environment Canada

20) The calculations done in making this point are not a correct use of our methodology. A point measurement was used as indicative of a basin response, whereas our methodology was based on basin average soil properties. It is quite likely that given specific data for one point in the system that yield predictions would be poor for any given crop. However, on the average, predictions should be reasonable. Predicted yields would vary. For example, taking data for site #107 yields well into the 100 percent productivity range are predicted.

21) The "ND" in the original tables was interpreted as "not detectable" instead of "not determined". The average hot water soluble boron concentration should be 3.5 instead of 1.6. This has been corrected in the final EIS.

22) 11. P. 205. The use of Figure 5.6-4 to predict young of year fish abundance should be re-assessed because of basic inconsistencies in the text. For instance, it is stated on page 200 that the Cromwell station on the East Fork had "the highest mean density of walleye eggs per sample when compared to all other 1978 sampling stations" and "about 13 times the densities" of young-of-the-year measured in 1977. On the other hand, Figure 5.6-4 suggests that the walleye and pike populations in 1978 should have been almost non-existent at the average flow of about 2.4 cfs. The conclusions presented in the summary (p. 2, 2nd para) are evidently based on applying Figure 5.6-4 to anticipated river flows without consideration of what has been observed to occur with low flow conditions.

23) 12. P. 208. Support for the IJC Biological Resources Committee peak flow recommendation of 700 cfs for two days should be qualified by taking into account the natural flow variation prior to development. Analyses in the attached document entitled "Comparison of Natural Spring Flows in the East Poplar River with Estimated Spillage from Morrison Dam" shows that 20 m^3/s (700 cfs) for 2 consecutive days in spring occurred only 30 percent of the years under natural conditions and for a single day duration only 43 percent of the years of record. On the other hand, the volume of water that would have been spilled at Morrison Dam in spring with two units operating during the period of record would have been sufficient to permit a 2 consecutive day release of 20 m^3/s in 33 percent of the years. This comparison between the natural and two unit spring flows should be pointed out.

Responses to Environment Canada

22) Additional discussion of flow recruitment relationships is incorporated in Section 5.6.4.2. The conclusions presented in the summary are not directly dependent on the absolute values presented in Figure 5.6-4, but are based on the generic relationship between spring flows and young of the year recruitment as discussed in this document and in the series of progress reports by Montana Department of Fish, Wildlife and Parks.

23) The comparison of peak flows under natural conditions to flows with the reservoir has been added to Section 5.6.4.2.

COMMENTS ON CROP YIELD SECTIONS OF THE EPA REPORT ENTITLED

"IMPACT OF CANADIAN POWER PLANT DEVELOPMENT AND FLOW APPORTIONMENT ON THE POPLAR RIVER BASIN"

Compiled by D.R. Cameron, Agriculture Canada, as a critical
review of one portion of the EPA Report.
Prepared for the IJC Poplar River Study Committee Members.

MAIN POINTS OF CONCERN

24) 1. The approach for calculating soil solution concentrations of B does not appear to be very valid.

25) 2. The TDS-to-EC conversion factor used by EPA (1 EC = 480 TDS) does not appear to be correct for the Poplar River basin waters where 1 EC ≈ 670 TDS.

26) 3. The EPA predicted salt concentration in soil solution (EC_{se}) are generally higher than those predicted previously by Rhoades (1979) and Cameron (1979).

27) 4. The adjusted SAR values are generally used to relate SAR_{iw} to SAR_{se}, but this report uses a different approach.

28) 5. The ln (SARxEC) vs. yield relationship is a novel approach that has not really been tested before to any great extent to my knowledge. The pitfalls of this approach, if any, remain hidden.

29) 6. The interpretation of the data to derive the ln (SARxEC) - yield plots can be improved considerably. There is also probably more available data in the literature that can be found and used.

30) 7. The EPA yield reduced graphs are biased in favor of higher losses at lower ln (SARxEC) values than would occur in reality.

31) 8. According to my interpretation of EPA's graphs, yield reductions to alfalfa would be negligible.

32) 9. Predicted yield reductions for wheat, barley, and oats seem high and a further more detailed examination of the literature should be done to investigate these results.

Responses to Agriculture Canada

24) The prediction of boron effects on crop yields has been primarily qualitative (see, for example, Ayers and Wescot, 1976). A methodology was developed to relate soil boron concentrations and the reaction of plants to these concentrations. The methodology was developed using the best available data. A detailed derivation of the methodology and the assumptions are shown in Appendix G. Based on comments on the draft EIS several changes have been made in the methodology.

25) Calculations involving the conversion of TDS to EC have been changed according to this recommendation.

26) For a leaching fraction of 0.1 the EPA estimates are higher, although for leaching fractions of 0.2 or greater the values are comparable.

27) The relationship between SAR in irrigation and drainage water was noted by Bower, Ogata and Tucker (1968) to be

$$SAR_{dw} = \sqrt{\frac{1}{LF}}\, SAR_{iw} \qquad (1)$$

therefore $\sqrt{LF} = SAR_{iw} / SAR_{dw}$

making the substitution

$$SAR_{dw} = f\left(\frac{SP}{FC}\right) SAR_e + (1-f)\, SAR_{iw} \qquad (2)$$

into 1 yields equation (3) which is analogous to the expression of Kamphorst and Bolt (1976) for EC; that is

$$SAR_e = \frac{SAR_{iw} - \sqrt{LF}\,(1-f)\, SAR_{iw}}{\sqrt{LF}\, f(SP/FC)}$$

28) The idea of using combined SAR and EC values to estimate crop yield losses was developed after review of the literature on this subject. The functions were parameterized using published values of the three variables EC, SAR and yield. In some cases SAR was not directly reported but calcium, magnesium and sodium data were included and SAR was calculated by Tetra Tech. This approach has not been used by others to our knowledge.

29) We feel that the data have been regressed properly. The regressions were based on linear least squares. Where the procedure is subjective, as Cameron has pointed out, is in the selection of the threshold for declining yield. We did not as he has stated, use all the 100 percent yield data in the regressions. Only the incipient 100 percent value (i.e. the farthest 100 percent value to the right) was used in the regression. This incipient point should be included. Other thresholds could be subjectively set.

30) See response 29.

31) Based on our interpretation of the available data we feel justified in retaining our conclusions of crop yields due to salinity effects. It should be pointed out that the yield values on page 13 of Cameron's comments attributed to EPA are not the correct values because the diluting effect of seasonal precipitation has not been included in his calculations.

32) An extensive literature review was conducted to obtain the data used to develop our methodology.

	Boron: Appendix G1 p. 200	Responses to Agriculture Canada
	The approach used by EPA is rather unique. They are using a different technique, almost a "backdoor" technique, for estimating soil solution equilibrium B concentrations. Their prime assumption (which is reasonable) is that the B soil solution concentration is directly related to the adsorbed B concentration in the soil. There are, however, some problems in developing this concept:	
33)	1. From the literature they related intercepts and slopes of the Langmuir adsorption isotherm to CEC. Their best fits accounted for only 20% and 38% of the variation.	Cameron's point is justified. Because the parameters of the Langmuir expression have not been evaluated for Poplar River basin soils they had to be estimated from data in the literature. The best fit of literature slopes and intercepts of the linearized Langmuir plots with a parameter which had been measured in the Poplar basin was with the soil cation exchange capacity. These regressions were accomplished with conventional least squares techniques. The literature data encompassed many types of soils and hence a wide variation of Langmuir coefficients. The power functions which relate Langmuir slopes and intercepts to CEC represent the results of an averaging process. Because of the wide variation around these mean values, the coefficients of determination of these regressions are low. However, no other alternative for estimating these coefficients was better. We note that an independent analysis of boron adsorption capacity (Saskmont Engineering, July 1979) based on field measurements gave 0.011 mg-B/g. The value used for the upper basin in our calculations was 0.0187 mg-B/g.
34)	2. The calculated K and Q coefficients of the Langmuir equation are derived from steady-state laboratory experiments on disturbed soils under stirred or agitated conditions. It is doubtful if such coefficients can be applied to an undisturbed structured field soil under dynamic flow conditions.	This point is debatable. Agitated, dispersed soils will probably have higher Q values than *in situ* soils because aggregates will be broken up exposing more sites for adsorption under experimental conditions. This may be countered by the fact that this dispersion also provides increased gradients for introduction of native boron into solution which is in turn available to occupy some of the adsorption sites. In another regard, Tanji (1970) studies boron adsorption/desorption in soil columns for these different soils in which the field profile was reconstructed and each horizon compressed to field bulk densities; in other words, *in situ* conditions were approximated. Langmuir 'K' values were higher (by a factor of 2) on the average *in situ* but lower for one soil. From these observations no definite conclusion can be reached as to the relative magnitudes of parameters *in situ* versus in laboratory experiments. Certainly no quantitative adjustment is supportable on the basis of these limited observations.
35)	3. The mass balance equation (2) does not appear to be correct in several ways: (a) The units do not match (i.e., mg B/gm of soil vs. mg B/l of soil solution) (b) The correction factor $(SP/\rho s)$ as given in equation (3b) cannot be applied to the field situation. The condition of saturation (SP) may apply at the time of irrigation, but not when the equilibrium concentration B_e is reached (c) The mass balance equation does not take into account the mass of boron lost by leaching - i.e., there is no leaching fraction.	a) The correct units of the parameters in the boron mass balance equation are given in Appendix G.
36)	4. A more realistic approach would have been as follows: $B_{ads} = V_{iw} B_{iw} - V_e B_e - V_{dw} B_{dw}$ where B_{ads} = mass of B adsorbed per given unit volume of soil, V_{iw} = volume of irrigation water applied, B_{iw} = concentration of B in irrigation water, V_e = volume of water remaining in the given volume of soil after irrigation (and possibly after plant use), B_e = equilibrium B concentration in the soil solution, V_{dw} = volume of drainage water lost from the unit volume of soil, and B_{dw} = concentration of B in the drainage water.	The mass balance equation has been revised to include drainage of boron during leaching. The equation can still be solved by hand using the quadratic formula as shown in the revised Appendix G.

The above mass balance equation is a little more complicated to solve (although by making certain assumptions it can be done). The plant uptake of water should be included in the water balance and perhaps B uptake by plants.

37) 5. Equation (3b) and thus equation (4) are derived with some assumptions (not presented in the report) that appear to be inaccurate. Unless EPA can show the rationale of their assumptions used to derive the mass balance equation, their results have little validity at this stage.

Boron: Main Report p. 129

38) 1. A more realistic derivation of the soil B concentrations was given by Rhoades (1979) and Cameron (1979) at the Scobey IJC Hearings.

2. A more comprehensive interpretation of the B data with regard to crop yields was also covered by Rhoades and Cameron, although their views began to differ at this point.

TDS (EC_{se}) - Appendix GI - p. 202

39) 1. The TDS-to-EC conversion factor used by EPA (1 EC = 480 TDS) does not appear to be correct for the Poplar River basin (1 EC = 670 TDS).

TDS	EPA Conversion	Poplar River Conversion
700	1.46	1.04
1000	2.08	1.49
1300	2.70	1.94

NOTE: The EC values used by EPA are about 40% higher than the true EC values in the Poplar River.

40) 2. Equation (5) is "outdated". Work by Rhoades and others has shown that this equation is not always an accurate prediction of soil solution equilibrium concentrations.

41) 3. The following table shows the comparison of using equation (5) to predict salt equilibrium concentrations in the soil as opposed to the methodology proposed by Rhoades (1979) and Cameron (1979).

Responses to Agriculture Canada

37) These equations have been replaced and the impacts reevaluated with the new mass balance procedure detailed under the response to Cameron's comments.

38) The methods used to predict boron concentrations in the soil have been revised to include the leaching fraction and to incorporate the comments of Cameron and others.

39) Calculations involving the conversion of TDS to EC have been changed according to this recommendation.

40) Cameron has used the word "outdated". We believe a more appropriate modifier might be "not appropriate to all field situations", as the remainder of his statement indicates. The work referred to by Rhoades indicates that a short-term salt imbalance may be allowable in the lower soil profiles since most crops preferentially use water from the upper soil zones. Eventually these salts must be removed, however, to maintain productivity. Ayers and Westcot, 1976, have stated that the crop may maintain productivity using a leaching requirement less than that predicted by the equation to which Cameron refers.

41) Because of the supportive nature of the results for leaching fractions of 0.2 or greater we believe we have used the correct methodology for estimating soil salinity.

Predicted Equilibrium Concentration (EC_{se})*

EC_{iw}	f	LF	from EPA EC_e	from Rhoades (1979) - linear average	from Cameron (1979) - weighted average
1.0	f = 0.6	0.1	8.0	3.75	2.93
	f = 1.0	0.1	5.0		
	f = 0.6	0.2	3.8	2.58	2.17
	f = 1.0	0.2	2.5		
	f = 0.6	0.3	2.4	2.05	1.83
	f = 2.0	0.3	1.7		
	f = 0.6	0.4	1.8	1.74	1.60
	f = 1.0	0.4	1.3		

*Assumed SP/FC = 2.0 and EC_{iw} = 1.0

42) 4. The EPA values for the low leaching fraction (0.1) are definitely overestimated with equation (5). Generally, those for flood irrigation (f = 0.6) are higher concentrations than predicted by Rhoades and Cameron, but the sprinkler (f = 1.0) are consistent at leaching fractions between 0.2 and 0.3.

43) 5. In light of the assumptions used in any of these proposed methods, I suspect that the estimates given in the EPA report for EC_{se} equilibrium concentrations are reasonable for leaching fractions near or greater than 0.2.

SAR - Appendix G1 - p. 204

44) 1. I have not spent very much time examining the origin and derivation of the SAR equations (8) and (9), nor do I at this stage see any real reason to do so.

45) 2. The commonly accepted practice for relating irrigation water SAR to resulting soil SAR is to calculate on adjusted SAR. The details of this calculation are described by Ayers and Westcot (1976) and briefly reiterated in the IJC Poplar River reports.

46) 3. The hazard, if any, from sodium (SAR) on the irrigated soils of the Poplar River will be one of reduced permeability. The adjusted SAR's are not nearly high enough to cause any direct toxic effects to the crops.

47) 4. The SAR effect on permeability in irrigated lands is related to salt concentration. Irrigation water with a high salt content can also have a high SAR without any reduced permeability effects. In other words, the more salt, the higher the critical SAR value can be.

Responses to Agriculture Canada

42) See response 41

43) See response 41

44) See response 27

45) Cameron makes reference to the method of Ayers and Westcot (1976) for determining soil SAR. First, the adjusted irrigation water SAR is calculated by

$$SAR_{adj} = SAR_{iw} (1 + (8.4 - pHc)) \qquad (10)$$

where SAR_{adj} = the adjusted SAR

SAR_{iw} = SAR of the irrigation water, and

pHc = a parameter which indicates the tendency of the irrigation water to precipitate or dissolve lime.

Then the adjusted SAR is used in an empirical relationship to estimate the soil SAR. They do not present a methodology for determining the SAR of the soil solution which accounts for the leaching fraction. Klarich (1978) has stated that SAR values in the Poplar River should be adjusted upward "about 0.5 as a result of calcium and magnesium carbon precipitation". Sensitivity analyses with the boron mass balance equation show that much larger changes than 0.5 may result from changing the leaching fraction. Thus, it appears that the inclusion of leaching fraction in the predictive methodology may be more important than the dissolution/precipitation adjustment for this area.

In addition the method by which SAR is adjusted involves a knowledge of the concentrations of Na , Ca , Mg , HCO_3 and CO_3 in the irrigation water. These constituents were not individually modeled and therefore no predictions were made for alternative scenarios. Thus Equation (9) could not be utilized in our studies.

46) No comment.

47) No comment.

	Appendix G1 - ln (SAR x EC) versus yields - p. 209	Responses to Agriculture Canada
48)	1. The Poplar River waters have relatively low SAR values and it is seriously doubted that SAR values will have any noticeable effect on the crop yields in the irrigated portion of the Poplar River basin. A threshold value of SAR = 10.0 was set by the Uses and Water Quality Objectives Committee (1979) of the International Poplar River Study.	No comment.
49)	2. I have examined most of the references used to derive Figures G-1.5 to G-1.8. None of the researchers have plotted their data (possibly for good reason) in the fashion proposed by the EPA where the interaction of (SAR * EC) is examined. The idea is novel. The paper by Torres and Bingham (1973) had little to do with the effect of SAR, rather it concentrated on the effect of NO_3 on Mexican wheats.	Although the paper by Torres and Bingham (1973) was not intended to assess the effect of salts and SAR on wheat yield directly, Ca, Mg, and Na were reported so that SAR could be calculated and yield regressed on ln (EC x SAR). SAR in nutrient solutions ranged from 0 to 72. Yields were averaged across nitrogen treatments to give a mean response to salts and SAR.
50)	3. The paper by Chang (1961) cautions on the non-linearity of the SAR (related to ESP) for given values of EC - - "...The departure from a linear relation when both excess ESP and salt are present may, theoretically, hinder the demonstration of linear correlation between crop yield and a single-value soil property, such as ESP or soluble salts ..." Chang (1961) goes on to state that "... saline irrigation water containing 3000 ppm dissolved salts did not depress alfalfa yield unless the sodium content of the irrigation water was high ..." (see his Figure 1 below). NOTE: 3000 ppm is about three times the expected TDS levels in the Poplar River.	Cameron's comments seem to point to the importance of evaluating interactive effects of both conductivity and SAR. The predicted TDS levels are greater than 3000 ppm on the East Fork at the International Boundary with four 300 MW units and year 2000 levels of development.
51)	4. Bernstein and Pearson (1956) do show a yield reduction in alfalfa of 12% (with VAMA) as the soil ESP increased from about 4.0 to 20.0. According to Ayers and Westcot (1976 - p. 95) this would be equivalent to irrigation water SAR value increases of 3.6 to 18.0. Similar yield decreases for the untreated soils (without VAMA) are close to 38%, showing the effect of sodium on permeability and related physical conditions that can affect plant growth and yield. NOTE: There are two problems with the interpretation of this data - (a) Yields in Figure 1 (from Berstein and Pearson - see below) are reported as fresh weights . The authors point out in their paper that	Both yields with and without VAMA were used in the ln (EC x SAR) versus yield regressions. a) Cameron has correctly pointed out that in the data of Bernstein and Pearson (1956) the fresh weights and dry weights of alfalfa do not decrease colinearly. However, the deviation is only 1.7 percent (i.e. dry weights varied between 19.3 and 21.0 percent of the fresh weight). b) It is unclear in this comment to which "data" Cameron is referring. Bernstein and Pearson's (1956) studies had ranges of SAR from 0.9 to 48.
52)		The articles which are noted here were available to us during our analysis.

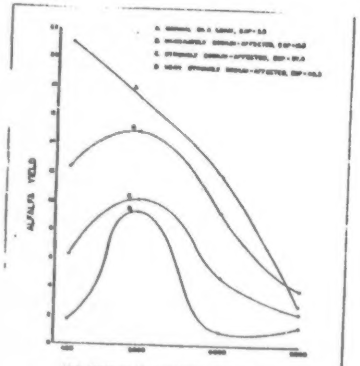


FIG. 1. Effect of saline irrigation water and exchangeable sodium percentage, ESP, on alfalfa yield (sodium equals 50 per cent of total cations in the water, and yield consisted of 2nd, 3rd, and 4th cuttings).

(Chang 1961)

EXCHANGEABLE SODIUM AND PLANT YIELD 251

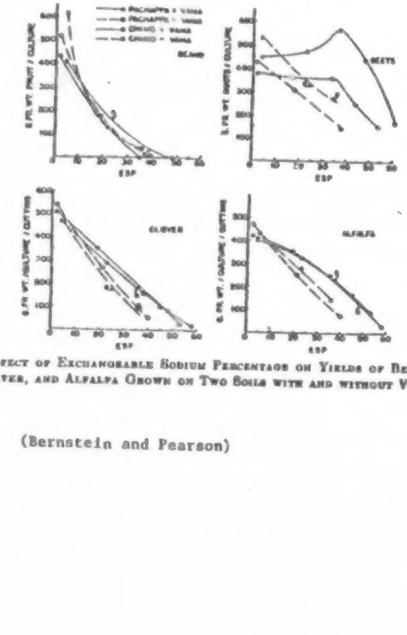


FIG. 1. EFFECT OF EXCHANGEABLE SODIUM PERCENTAGE ON YIELDS OF BEANS, BEETS, CLOVER, AND ALFALFA GROWN ON TWO SOILS WITH AND WITHOUT VAMA

(Bernstein and Pearson)

dry weights increased consistently as per cent fresh weight with increasing ESP. (In other words, the equivalent dry weight curves in Fig. 1 (Bernstein and Pearson) would not decrease as sharply as indicated.)

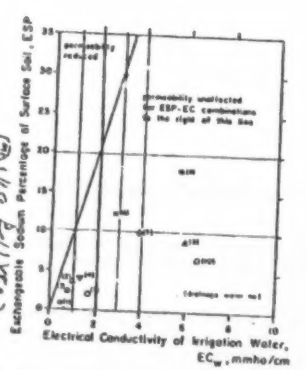
(b) The extrapolation of data between estimated SAR values of 3.8 and 18.0 leaves room for doubt when the highest predicted river water values are near 9.0. The information presented is not detailed enough to determine a critical cut-off point (threshold point) at which yields begin to decrease. I believe a cut-off point of SAR = 10 is commonly used for irrigation waters.

52) 5. It would seem that the ln (SAR * EC) relationship versus yield has not been widely used and tested by experts in the field.

Rhoades (1977) has shown that irrigation water with an EC of 1.5 (over 1000 ppm) can be used on a soil with a surface ESP of nearly 15 without any reduced permeability (see Fig. below - Rhoades 1977). I suspect that the EPA researchers might benefit from such references as Maas and Hoffman (1977), Oster and Rhoades (1976), Rhoades and Merrill (1975), and Ayers and Westcot (1976).

SALINE DRAINAGE

18



$ESP_t = (.5)(Adj. SAR_{iw})$

Figure 8. Comparison of ESP-EC combinations produced with use of drainage water for irrigation with those associated with adequate and inadequate soil permeability.

(Rhoades 1977)

53) 6. If figures G-1.5 to G-1.8 are deemed to be acceptable, then they should be analysed and regressed properly. In most cases the EPA threshold point for the beginning of yield reduction is far too low. In these graphs, a realistic eyeball fit probably would have served a more useful purpose. The EPA versus my choices for threshold values are shown below:

Critical ln (SAR x EC) threshold values
at which yield reductions being to occur

Crop	EPA criteria	Realistic Choice
Alfalfa	1.7	4.0
Wheat	0.4	2.6
Barley	1.5	2.7
Oats	1.8	3.0

The revised EPA graphs are shown on the next four pages. It is apparent that the EPA regression lines are biased to the LHS because they included all the 100% yield data. This data should have been ignored and the yield decrease information should have been regressed. The more realistic estimates of threshold values that I have presented above are derived from a "best fit" line through the yield decrease data. In one sense, the more realistic threshold estimate is conservative in that the EPA 100% yield is too high as it is biased toward the extreme high yields. In reality (when accounting for variability) the 90-95% yields are probably more representative of "average" 100% yields.

54) 7. If the ln (SAR x EC) is used, then it must not be forgotten that the SAR x EC interaction will be predicted less accurately than any single measurement by itself.

55) 8. Using EPA's equations for predicting soil EC_e (eq. 6) and soil SAR_e, results were obtained for the situation where EC_{iw} = 2.0 (TDS = 1340) and SAR_{iw} = 9.0. These values resemble some of the worst average conditions thay may be encountered in Poplar River basin, namely those of Station 12, the outlet to the Missouri. Similarly, the predicted ln (SAR x EC) results were calculated for the next worst situation at Station 8, the northern boundary of the Ft. Peck Indian Reservation. Here EC values of 1.5 (TDS = 1005) and SAR values of 6.5 were assumed to be realistic averages.

Responses to Agriculture Canada

53) See Response 29.

54) Comment noted.

55) See Response 31.

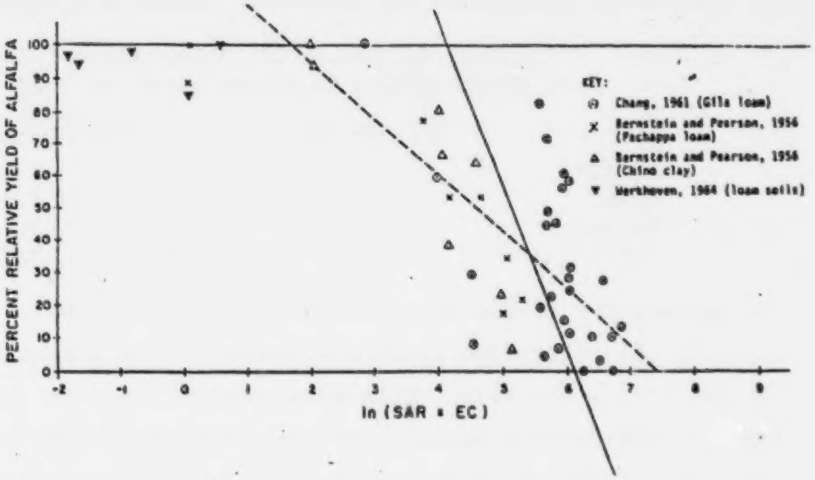


Figure G-1.5 PERCENT ALFALFA YIELD VERSUS f(EC,SAR) IN SATURATION EXTRACT

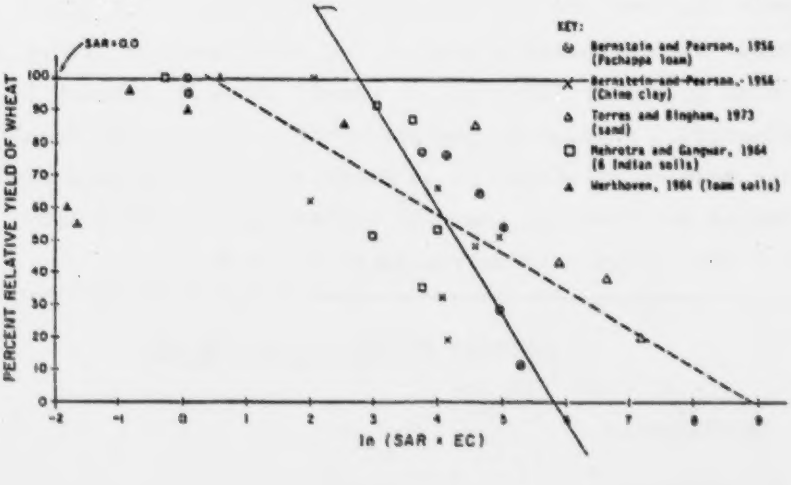


Figure G-1.6 PERCENT WHEAT YIELD VERSUS f(EC,SAR) IN SATURATION EXTRACT

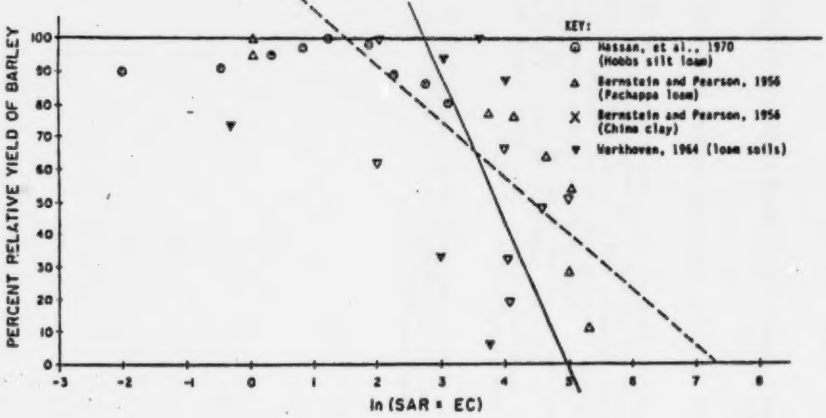


Figure G-1.7 PERCENT BARLEY YIELDS VERSUS f(EC,SAR) IN SATURATION EXTRACT

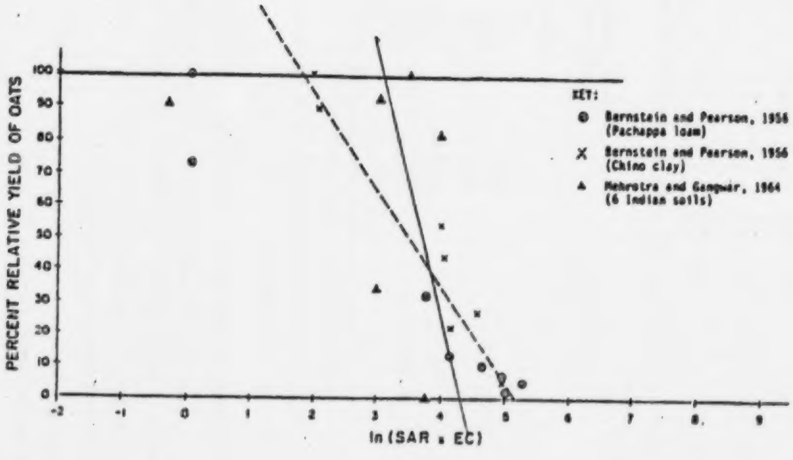


Figure G-1.8 PERCENT OAT YIELD VERSUS f(EC, SAR) IN SATURATION EXTRACT

Predicted ln (EC x SAR) values using EPA equations

EC_{iw}	SAR_{iw}	LF	f	EC_{se}	SAR_{se}	ln (EC x SAR)
2.0	9.0	0.2	0.6	7.6	13.7	4.6
			1.0	5.0	10.0	3.9
		0.3	0.6	4.8	10.6	3.9
			1.0	3.4	8.2	3.3
1.4	6.5	0.2	0.6	5.7	9.9	4.0
			1.0	3.8	7.2	3.3
		0.3	0.6	3.6	7.7	3.3
			1.0	2.6	5.9	2.7

56) 9. The predicted yield decreases from optimum yield (given the above information) are shown below:

EC_{iw}	SAR_{iw}		% Yield reduction from optimum*	
			Cameron	EPA
2.0	9.0	Alfalfa	0%	40%
ln (SAR x EC) = 3.9		Wheat	38%	42%
		Barley	56%	42%
		Oats	70%	64%
1.5	6.5	Alfalfa	0%	27%
ln (SAR x EC) = 3.3		Wheat	17%	23%
		Barley	28%	29%
		Oats	23%	47%

*Yield reductions were calculated using G-1.5 to G-1.8 graphs as modified by Cameron and as originally presented by EPA.

NOTE: The primary difference between my prediction and EPA's is that I do not show any impairment of alfalfa yields.

SAR - EC Impacts on Crop Yields - Main Report - p. 136

57) 1. The EC units used in deriving the G-1.5 to G-1.8 graphs were in units of mmho/cm (I think, rather than μmho/cm) as suggested on p. 138.

58) 2. P. 138, para. 2 - on examination of the data, I cannot agree with the conclusions reached in this paragraph.

59) 3. Under one the worst conditions, alfalfa yield reduction was shown to be negligible rather than the 48% proposed by EPA.

60) 4. Combined effects of B, SAR, and EC - also see appendix, tables G-1.2 to G-1.5.

61) I have no idea how the EPA research team managed to couple the B effects and the salt effects. Perhaps I missed a section in the report.

Responses to Agriculture Canada

56) See response 31.

57) Cameron is correct. The units on page 138 for EC have been changed to mmho/cm.

58) Again, these conclusions are based on an objective analysis of the available data.

59) This point has already been commented upon (see response 53).

60) The effects of boron and salt accumulation on crop yield were assumed to be independent and additive. The effects of salts on plant growth are primarily osmotic (Rhoades, 1977). Plants under salt stress have fewer and smaller leaves. Boron excesses produce symptoms of an acute toxicant such as leaf necrosis. Although several studies have been done pointing out the interactions of calcium, potassium and nitrogen and boron (Berger, 1949) there is no basis for quantifying an interaction between high salts and boron. It would seem, however, that plants already in poor health are probably more susceptible to boron injury.

61) As discussed above, the yield changes due to boron were added to the yield changes due to the combined effects of salinity and sodicity. This is the best method presently available.

CAMERON'S REFERENCES

Ayers, R.S. and D.W. Westcot. 1976. Water quality for agriculture. FAO Irrig. and Drainage Paper 29. 97 pp.

Bernstein, L. and G.A. Pearson. 1956. Influence of exchangeable sodium on the yield and chemical composition of plants: I. green beans, garden beets, clover and alfalfa. Soil Sci. 82: 247-258.

Cameron, D.R. 1979. Poplar River boron and TDS objectives. Rept. to IJC Poplar River Hearings, Scobey, Montana, Oct. 16-17.

Chang, C.W. 1961. Effects of saline irrigation water and exchangeable sodium on soil properties and growth of alfalfa. Soil Sci. 91: 29-37.

EPA. 1980. Impact of Canadian Power Plant development and flow apportionment on the Poplar River Basin. Draft Environmental Impact Statement, Montana EPA Office. 227 pp.

International Poplar River Water Quality Study. 1979. Appendix D: Uses and Water Quality Objectives. 171 pp.

Oster, J.D. and J.D. Rhoades. 1976. Various indices for evaluating the effective salinity and sodicity of irrigation waters. U.S. Salinity Lab., Riverside, Calif. Int. Salinity Conf. Proc., Texas Tech. Univ., Labbock, August 1976, pp 1-14.

Maas, E.V. and G.J. Hoffman. 1977. Crop salt tolerance - current assessment. J. Irrig. and Drainage Div., ASCE 103: 115-134.

Rhoades, J.D. 1977. Potential for using saline agricultural drainage waters for irrigation. Proc. Water Management for Irrig. & Drainage. ASCE, Reno, Nevada, July 20-22.

Rhoades, J.D. 1979. TDS and B standards. Rept. to IJC Poplar River Hearings, Scobey, Montana, October 16-17.

Rhoades, J.D. and S.D. Merrill. 1976. Assessing the suitability of water for irrigation: Theoretical and empirical approaches. FAO Soils Bull. 31: 69-109.

Torres, C. and F.T. Bingham. 1973. Salt tolerances of Mexican wheat: I. Effect of NO_3 and NaCl on mineral nutrition, growth, and grain production of four wheats. Soil Sci. Soc. Amer. Proc. 37: 711-715.

DEPARTMENT OF THE ARMY
OMAHA DISTRICT, CORPS OF ENGINEERS
6014 U.S. POST OFFICE AND COURTHOUSE
OMAHA, NEBRASKA 68102

REPLY TO
ATTENTION OF

OCT 09 1980
TETRA TECH INC.
LAFAYETTE, CALIF.

MROPD-A

29 September 1980

Mr. Gene Taylor
Environmental Protection Agency
Federal Building, Drawer 10096
301 South Park
Helena, Montana 59601

Dear Mr. Taylor:

We have reviewed the Draft Environmental Impact Statement concerning the impact of Canadian Power Plant Development and Flow Apportionment on the Poplar River Basin and have the following comments.

62) a. It would appear that there is an error in the presentation of the detailed flow reductions on Page 1, Paragraph 2, Section 1.1 in Water Quality Impacts. The formula for flow apportionments as stated in this paragraph would not allow a 50/50 division of flow at the border.

63) b. It appears that almost all of the water quality data used had been obtained during 1975. Was the assumption made that 1975 represented an average year? It also appears that modeling efforts were substituted for actual data gathering in some instances.

We appreciate your including us in the review process and look forward to receiving subsequent documents.

Sincerely,

ARVID L. THOMSEN
Acting Chief, Planning Division

OCT 1980
MONTANA OFFICE

TO:
Gene

☒ YOU WERE CALLED BY— ☐ YOU WERE VISITED BY—

Corp Engr. - Omaha
OF (Organization)

☐ PLEASE CALL → PHONE NO. CODE/EXT. ☐ FTS
☐ WILL CALL AGAIN ☐ IS WAITING TO SEE YOU
☐ RETURNED YOUR CALL ☐ WISHES AN APPOINTMENT

MESSAGE
There's an error in the Sept 29 memo to you from them regarding Can Power Plant Devel. + flow apportionment in Poplar River Basin. Item B- quality should be quantity.

RECEIVED BY	DATE	TIME
Deb	10-3	9:00

63-108
● U.S. G.P.O. 1980-311-156/25
STANDARD FORM 63 (Rev. 8-76)
Prescribed by GSA
FPMR (41 CFR) 101-11.6

Responses to Department of the Army

62) Has been corrected - see response #3

63) The year 1975 was defined as the baseline year by the EPA. It was not intended as an average year only that it is the last year before construction of Cookson Reservoir. Since there presently is no flow apportionment, modeling results had to be used to compare the various scenarios. Actual flow data for 1974 through 1979 were reviewed.

RECEIVED
OCT 09 1980
TETRA TECH INC.
LAFAYETTE, CALIF

DEPARTMENT OF HEALTH AND HUMAN SERVICES
REGION VIII
FEDERAL OFFICE BUILDING
1961 STOUT STREET
DENVER, COLORADO 80294

October 2, 1980

OFFICE OF THE
PRINCIPAL REGIONAL OFFICIAL

ROFEC

Mr. Gene Taylor
Environmental Protection Agency
Federal Building, Drawer 10076
301 South Park
Helena, Montana 59601

Dear Mr. Taylor:

This Department has reviewed the Draft Environmental Impact Statement on Powerplant Development and flow apportionment on the Poplar River Basin.

64) The Poplar River Basin Area of northeast Montana has experienced a minor influx in population in recent years. This is due almost entirely to the oil and gas exploration activity and has no relationship to the Canadian powerplant construction nearby. In general, the local populace in the affected Montana area is aware of the powerplant project, and apparently has little, if any concern about it.

No significant impact on social conditions in Northeast Montana is evident.

Sincerely yours,

Thomas E. Moore

Thomas E. Moore, P. E.
Director, ROFEC
Regional Enviromental Officer

Response to Department of Health and Human Services

64) The population changes presented in Table 4.10-1 are not ascribed to power plant construction.

1980
NTANA OFFICE

DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT
REGIONAL/AREA OFFICE
EXECUTIVE TOWER - 1405 CURTIS STREET
DENVER, COLORADO 80202

REGION VIII

September 17, 1980

IN REPLY REFER TO:

8SOQ-0044d

Mr. Gene Taylor
Environmental Protection Agency
Federal Building, Drawer 10096
301 South Park
Helena, Montana 59601

Dear Mr. Taylor:

Thank you for the opportunity to review and comment on the draft Environmental Impact Statement (EIS) of the Impact of Canadian Power Plant Development and Flow Apportionment on the Poplar River Basin.

Your draft has been reviewed with specific consideration for the area of responsibility assigned to the Department of Housing and Urban Development (HUD). The review considered the proposal's compatibility with local and regional comprehensive planning and impacts on urbanized areas.

65) The Missouri River Basin Commission has been preparing a comprehensive plan for the area included in your EIS. It is not clear in your draft EIS that their plan was considered. They may be contacted at:

Missouri River Basin Commission
Upper Missouri River Basin
1123 Missoula Avenue
Helena, Montana 59601

If you have any questions regarding these comments, please contact Mr. Carroll F. Goodwin, Area Environmental Officer, at FTS 327-3102 here in Denver.

Sincerely,

Raymond D. McKinney

Raymond D. McKinney
Director
Program Planning and Evaluation

AREA OFFICE
Denver, Colorado

Response to Housing and Urban Development

65) The Draft Basin Plan was completed in July 1980 after preparation of the DEIS. The Plan has been reviewed. However, the plan covers a much larger area and does not present information for the Poplar River basin itself.

United States Department of the Interior

OFFICE OF THE SECRETARY
WASHINGTON, D.C. 20240

NOV 24 1980

ER-80/927

Mr. Gene Taylor
Environmental Protection Agency
Federal Building
301 South Park
Helena, Montana 59601

Dear Mr. Taylor:

Thank you for your letter requesting the Department's comments on the Draft Environmental Impact Statement (DEIS) for the impact of a Canadian Power Plant on development and flow apportionment in the Poplar River Basin, Montana.

Apparently, contradictory statements about the apportionment of flow in the
66) Middle Fork Poplar River (whether the flow is to be 60 percent or the
reduction in flow is to be 60 percent) suggest the possibility that
calculations of the data presented in the DEIS may have been based on an
incorrect interpretation of the recommended apportionment. The Department is
also concerned about the adverse impacts that will occur on the Fort Peck
67) Indian Reservation once the plant commences operation in Canada. Steps must
be taken to insure that the rights of the Fort Peck Indian Reservation are
taken into account. Additional comments explaining these two points are
included in the attached materials. Specific comments are also included in
the attached memoranda from the Bureau of Indian Affairs, Water and Power
Resources Service, and the Geological Survey.

Thank you again for the opportunity to review the document. I hope you will find our comments and recommendations helpful.

Sincerely,

James H. Rathlesberger
Special Assistant to
Assistant Secretary
Policy, Budget,
and Administration

Responses to U.S. Department of Interior

66) The DEIS calculations are correct. See response 3.

67) One of the purposes of the EIS is to identify adverse impacts so that mitigation measures can be determined.

memorandum

DATE: SEP 3 - 1980

REPLY TO ATTN OF: Environmental Quality

SUBJECT: Review of draft environmental statement and Appendix for the Impact of the Canadian Power Plant on Development and Flow Apportionment, Poplar River Basin, Valley Daniels and Roosevelt Counties, Montana (ER 80/927)

TO: Assistant Secretary, Land and Water Resources
Attn: Claire Newcomer

From: Office of the Area Director [Bureau of Indian Affairs]

In accordance with our Central Office's request to review and provide comments on the subject statement to your office, we wish to submit the following comments:

This office is understandably disturbed to read of the adverse impacts that will occur on the Fort Peck Indian Reservation once the coal fired generating plant commences operation in Canada. The plant is scheduled to be operational in October 1980, with a second 300 MW unit to be operational in 1982. Adverse impacts attributable to plant operation include:

68) 1. Reduced flow of 50% of the West Fork and at least 60% of the Middle Fork. Summer flows in the East Fork will be approximately 35-65% less with one power plant and up to 80% less with four power plants.

2. Resultant water quality will be decreased with possible harmful effects to croplands, fish, furbearers, waterfowl, etc.

3. SO_2 concentrations from two 300 MW units could exceed the Class 1 PSD regulations proposed at the Fort Peck Indian Reservation.

69) Considering the above it is our suggestion that all steps that can be taken to protect water and air quality should be undertaken. Water flows should be apportioned as equitably as possible and provide adequate waters for the development of Indian lands. It must be remembered that Indian water rights have been established by judicial decree. The Indians' prior and paramount rights were sustained in the U.S. Supreme Court case familiarly known as "Winters Doctrine". The Winters Doctrine embraces reservation rights whether created by treaty statute, or executive order, before or after statehood. The waters reserved cannot be preempted by non-Indians pursuant to State law. It is important to remember that during the apportionment process that it has been determined that the courts have consistently held that the nature of the right was such that sufficient water has been reserved for accomplishing the purpose for which the reservation was established and to provide for the present and future needs of the Indians, whatever the use and without limit.

Buy U.S. Savings Bonds Regularly on the Payroll Savings Plan

OPTIONAL FORM NO. 10
(REV. 7-76)
GSA FPMR (41 CFR) 101-11.6
5010-112

Assistant Secretary, Land and Water Resources
Attn: Claire Newcomer
September 18, 1980
Page 2

We submit that every step must be taken to insure that the rights of the Fort Peck Indian Reservation are taken into account and that apportionment is made on an equitable basis.

DEPUTY Area Director

Responses to Bureau of Indian Affairs

68) This statement is incorrect. The flows would be reduced by 50 percent on the West Fork and up to 40 percent on the Middle Fork due to the recommended apportionment only if Canada retains its full allotment. The construction of the two proposed reservoirs on the Fort Peck Indian Reservation would increase the water available for use on the reservation.

69) A discussion of the Winters Doctrine and Boundary Waters Treaty has been added to the EIS in Chapter 2. The projected future water uses on the Fort Peck Indian Reservation have been included in the water quantity analysis.

WM-150

SEP 18 1980

Memorandum

To: Commissioner
Attention: 700

From: Regional Director, Billings, Montana

Subject: Draft Environmental Statement and Appendix for the Canadian Power Plant, Poplar River Basin Montana (ER 80/927) (Mr. Al Jones's August 26 Memo)

Per oral instructions from Mr. Specht, we are submitting our comments directly to you rather than Mr. Blanchard as requested in Mr. Jones's memorandum.

The proposed power plant and flow apportionment will have no direct effect on projects of the Water and Power Resources Service.

70) The analysis of impacts would be improved if available figures were used rather than adjectives. Page 59 refers to "significant breeding populations of waterfowl" which interpretation of data on page 192 reveals to be 140-160 breeding pairs. On page 191 it is reported that "from 1977 to 1978 the number of observations of beaver and raccoon . . . increased slightly." "Slightly" could mean from 10 to 11 or from 110 to 111 with vastly different significance when no projections on numbers of animals are presented.

71) Discussions of the proposed apportionment in the summary and in Section 1.1 (Water Quantity Impacts) imply that the flows in the basin will be reduced under conditions of the apportionment. The proposed apportionment states that the natural flow of the Poplar River shall be divided equally subject to conditions imposed on each tributary. It further states that Canada shall deliver at least 60 percent of the natural flow of Middle Fork and that the natural flow of the West Fork shall be divided equally. The statements in the summary (second paragraph and in Section 1.1 - second paragraph) do not correctly convey the meaning of the proposed apportionment. If the recommended apportionment was not interpreted correctly, any analysis or scenario based upon that interpretation would be incorrect. The Canadian use of Poplar basin water would be limited to the percentages as stated in the recommended apportionment.

72) Several references in the report are made to natural flow in the West Fork, the Middle Fork, and the East Fork under conditions of the recommended apportionment. It should be emphasized that the flow percentages are referenced to the International Boundary and that tributary streams other than those mentioned above are also included.

73) The analysis used to determine the mean annual natural flows at various points in the Poplar River basin differed from that used by the Poplar River Task Force. For example, the mean annual natural flow of the Poplar River near Poplar was estimated to be 92,560 acre-feet by the Task Force as opposed to 83,860 acre-feet in this report. Similar differences occur at other stations. The annual natural flow of the East Fork Poplar River at the boundary has ranged from 2,640 acre-feet to 46,790 acre-feet, not from 0 to 32,000 acre-feet as stated in the report.

74) The discussions on pages 13, 15, 16, and 17 refer to stations (e.g., 3, 8, 7 etc.) where predictions of impacts are made. An explanation as to the station locations or a map showing the locations would be helpful.

75) Figure A-3.4 (Poplar River at Poplar) in the appendix appears to have an erroneous horizontal scale.

Joseph B. Marcotta, Jr.

EPDENSON:clb 9/17/80

Responses

70) Numerical increases have been stated in text.

71) The recommended apportionment was interpreted correctly. (See response 3).

72) Explanation to Section 5.2.1.1. Flow Scenarios is added explaining that flow percentage is based on total flow at the International Border and that small tributaries to the main forks are included.

73) Flows given in Table 4.4-2 are expected annual flows (or median) not mean annual flows. The table incorrectly stated values in cfs were mean flows. True mean natural flows from the Poplar River Task Force Appendix B have been added to Table 4.4-2 to avoid confusion. The flow range has been corrected in the Summary.

74) The map with station locations (Figure 5.2-1 p 92) has been moved to the summary at the beginning of the report.

75) The scale on Figure A-3.4 has been corrected.

UNITED STATES GOVERNMENT

Memorandum

SEP 1 9 1980

U. S. GEOLOGICAL SURVEY

DATE: September 12, 1980

TO : Mr. L. D. Bonhen, Chief, Review Branch, USGS,
Environmental Affairs Office, MS 760, Reston, VA

FROM : Claude O. Geiger, Hydrologist, USGS, WRD, Lawrence, KS

SUBJECT: REPORTS -- Draft Environmental Impact Statement, Poplar River Basin

The Draft Environmental Impact Statement, " Impact of Canadian Power Plant Development and Flow Apportionment on the Poplar River Basin", prepared by the U.S. Environmental Protection Agency, Montana Office, has been given a cursory review because of the limited time available. The following suggestions and comments are offered for your consideration:

SUMMARY page

76) para. 3. Summary of Environmental Impacts: "The Poplar River flows will be reduced under conditions of the recommended apportionment up to 50 percent of the natural flow in the West Fork" and tributaries "and" up to 40 "percent of the natural flow on the Middle Fork."

77) This paragraph also mentions "summer flows". In which months do "summer flows" occur? The flow on the East Fork at the boundary, for July, is estimated to be greater under the proposed apportionment, with one power plant in operation, than under natural conditions. It is assumed that the reduced flow percentages, documented in this paragraph, are referenced to the boundary and not to some other location in the basin.

Page 1

1.1 WATER QUANTITY IMPACTS

78) para. 1: The mean annual natural flow of the Poplar River, as determined at the USGS gaging station near Poplar, Montana, was estimated to be 92,560 acre-feet (See Poplar River Task Force Report, dated January 1976, Appendix B, page B-36). About 35 percent of this mean annual natural flow comes from Canada. The annual natural flow on the East Fork at the boundary has ranged from 2,643 acre-feet to 46,791 acre-feet (See Poplar River Task Force Report, dated January 1976, Appendix B, page B-30).

Buy U.S. Savings Bonds Regularly on the Payroll Savings Plan

Responses to U.S.G.S.

76) See response 3.

77) Summer flows refer to June through September. Flow reductions are discussed on p. 139 of the final EIS and show reductions from natural conditions in June and July based on the release schedule from the reservoir used in the model.

78 The value of 83,860 ac-ft is the expected or median annual flow (see Table 4.4-2). The summary has been changed to show the mean annual flow of 92560 ac-ft. Both values are now shown in Table 4.4-2. The percent flow from Canada is 35 percent based on the mean annual flow. The percentage of 32 was based on the median year. The flow range has been corrected.

		Responses to U.S.G.S.
79)	Para. 2: "The flows", at the boundary." will be reduced under conditions of the recommended apportionment up to 50 percent of the natural flow on the West Fork" and tributaries "and" up to 40 "percent of the natural flow on the Middle Fork." In which months do "summer flows" occur? The flow on the East Fork at the boundary, for July, is estimated to be greater under the proposed apportionment, with one power plant in operation, than under natural conditions. It is assumed that the reduced flow percentages, documented in this paragraph, are referenced to the boundary and not to some other location in the basin.	See responses 76 and 77.
80)	In all fairness, it should be noted that shortages would occur in the year 2000 even if the United States received 100 percent of the natural flow, as determined at the boundary.	This point is discussed in Chapter 5 and is discussed in the expanded summary.
81)	It should also be noted at this time that the remainder of this review is purely academic if the proposed apportionment for the Middle Fork was interpreted incorrectly. It has been stated, incorrectly, that the flow on the Middle Fork could be reduced "at least 60 percent of the natural flow". This interpretation would result in erroneous computations of flow, not only on the Middle Fork but on the Poplar River below the confluence of the East Fork and below the confluence of the West Fork. I have been in contact with the Montana Office of the Environmental Protection Agency, concerning this interpretation, and they have been unable to provide any satisfactory answers. As further support of the incorrect interpretation theory, page 97 of the Environmental Impact Statement produces a "bar graph" defining the various Canadian water uses on the Middle Fork for the year 2000. This "bar graph" defines approximately 6,900 acre-feet of Canadian usage, whereby the Canadian share of the natural flow, under the proposed apportionment, would be no more than 5,184 acre-feet.	As discussed in response 3, the flow apportionment was interpreted correctly and confirmed by Richard Karp who did the modeling for the State of Montana. Canadian water uses are projected values by Canada shown to consider what future diversions might be without apportionment and when interbasin transfers might take place, but are not used by the model.
82)	Page 13 3.2 FLOW RELATED ALTERNATIVES 3.2.1 Alternative Flow Apportionments para. 1: Twenty-two "alternative apportionments were considered."	Twenty-two flow apportionments were considered by the Poplar River Tast Force in 1976 but only four apportionment alternatives were selected to be evaluated by the EPA. These alternatives were modeled along with the no apportionment case and the present case with the Cookson Reservoir. This section has been rewritten to explain the various apportionments.
83)	Page 37 para 2: "The mean" natural "flow of the Poplar River at the basin outlet is" 127.8 cfs (See Poplar River Task Force Report, dated January 1976, Appendix B, page B-36).	Value in EIS was based on median flow. This has been changed in the summary and Table 4.4-2.

	Page 33		Responses to U.S.G.S.
84)	Table 4.4-2: The mean annual natural flows do not agree with Poplar River Task Force determinations (see Poplar River Task Force Report, dated January 1976, Appendix B, pages B-28, B-29, B-30, and B-36).	84)	Table 4.4-2 has been changed to include mean annual flows in ac-ft along with the median flows (or expected values).
	Page 91 5.2 WATER QUANTITY IMPACTS 5.2.1 Methodology 5.2.1.1 Flow Scenarios		
85)	para. 2: "The historical water uses were then added to the observed flows to give the natural flows under predevelopment conditions with no apportionment." The natural flow, at various points, was determined by the Poplar River Task Force (See Poplar River Task Force Report, dated January 1976, Appendix B, pages B-28 to B-39). Natural flow, by definition, is the flow that would have occurred in rivers and streams without the influence of man on the flow regime.	85)	The subject report states: "Natural streamflow estimates were derived by adding upstream consumptive uses to estimated historic flows". The text in the EIS has been revised to clarify this point.
86)	para. 3: "Flow in Cow and Coal Creeks (stations 2 and 5) must be at least" 40 "percent of the natural flow". "If flow releases are needed to meet the apportionment, the releases are made from stations 2 and 5 first and station 4 second." There are no facilities from which to make releases at stations 2 and 5.	86)	The percentage of flow was changed from 60 to 40. The releases are made at stations by the computer model to simulate the apportionment. This has been made clear in the text.
	Page 97		
87)	Figure 5.2-3: Under the conditions of the proposed apportionment, Canada will not receive 6,900 acre-feet of water in the year 2000. Also, the power plant symbol of the legend is missing.	87)	See response 81. Power plant legend has been added.
	Pages 96-98		
88)	Figures 5.2-2, 5.2-3, 5.2-4: Is the "Reservoir Evaporation", referenced in these figures, natural evaporation or both natural and forced evaporation?	88)	The reservoir evaporation in the figures includes both natural and forced evaporation. A note has been added to the text explaining this.
	Page 98		
89)	Figure 5.2-4: The title of this figure should be "Canadian Water Uses on the West Fork and tributaries".	89)	Figure title has been changed.
	Page 110		
90)	para. 2: "In June all scenarios bring about a 63 percent reduction in the natural flows". There would be no reduction in the "natural flow"; however, there would be a reduction in the "observed flow".	90)	Text changed to read "from natural flows".

TO: John Stanley

			Responses to U.S.G.S.
91)	para. 5: "The flows in the West" Fork and tributaries "(station 9" and 10) under Apportionment VI are specified as 60 percent of the natural flow."	91)	Text changed to read "West Fork and tributaries".
	Page 117		
92)	para. 1: Flow on the East Fork at the boundary is expected to be greater, in July, under the proposed apportionment than under natural conditions.	92)	These diagrams show that July flows are not greater under the apportionment according to the modeling results for EPA's scenarios.
93)	para. 4: "In the West Fork at the International Boundary, flows under scenarios 28 through 32 will be zero for all months." How would this be possible under the proposed apportionment, when it specifically states, "The total natural flow of the West Fork Poplar River and all its tributaries crossing the international boundary shall be divided equally between Canada and the United States but the flow at the international boundary in each tributary shall not be depleted by more than 60 percent of its natural flow."?	93)	The zero flows on the West Fork were for the case of a 1 in 10 year drought. Zero flow on the computer results means less than 0.004 hm /month or 3.2 ac-ft/month. In addition the Poplar River Task Force (1976, Appendix B, p. B-6) stated that flows were assumed to stop on the West Fork at the International Boundary during December to February under natural conditions. Flows on the Middle Fork at the boundary were assumed to stop from January through March unless an early thaw occurred for that year. A note has been added to the beginning of the modeling section to explain this.
	Page 120		
94)	para. 1: "The water uses in March (1975) were estimated as" 441 "ac-ft for spreader irrigation," 84 "ac-ft for stock and 17.5 ac-ft for municipal water supply" (See Poplar River Task Force Report, dated January 1976, Appendix A, page A-22). Much of the spreader irrigation requirement is fulfilled with runoff from tributaries downstream from the boundary, as noted in the preceding reference, and does not depend on water crossing the boundary on the East Fork.	94)	The water uses given here are the values used in the modeling work. The uses may have been updated by the IJC after 1976. While it is true that some of the spreader irrigation is met from small tributaries, the model used a conservative approach and subtracted all uses from the main stem Poplar and the forks as appropriate.
95)	"The available water before diversions is estimated as" 601 "ac-ft" (from Appendix B, page B-33, of Poplar River Task Force Report and computer run, using the proposed apportionment with two power plants in operation).	95)	The 601 ac-ft does not consider the prescribed schedule of releases to the East Fork from the recommended apportionment. Additional water would probably be available from spring runoff but this is not included here because the EPA wanted to use a conservative approach.
96)	Table associated with para. 2: Curiously, the available water is the same for March, April (noted in paragraph 1), August, and September. This would not be possible, as there would be spills occurring occasionally in March and April; and dictated by the proposed apportionment, the minimum continuous release is subject to change on September 1.	96)	The available water is at the same minimum level in March, August and September only for the 1 in 10 year low flow case.
	Page 203		
97)	Table 5.6-8: It is difficult to believe that the flow on the East Fork near Scobey would be zero under scenario 32 and a 10 percentile. This should be checked.	97)	These flows are derived from the model runs in ac-ft/month so the flow could be low but not actually zero (see response 93).

TO: John Dooley

APPENDIX

Page 183

98) Table E-4: For the year 2000, on the Middle Fork, the Canadian water usage of 6,870 ac-ft is incorrect because, under the terms of the proposed apportionment, Canada is entitled to no more than 40 percent of the natural flow. The estimated mean annual natural flow of the Middle Fork is 12,961 ac-ft (See Poplar River Task Force Report, dated January 1976, Appendix B, page B-29).

The West Fork total, for the year 2000, is also incorrect if this figure does not include tributaries of the West Fork.

In Summary, due to time restraints and the lack of some pertinent information, it is difficult to provide a thorough review of this report. However, based upon some of the discrepancies noted previously, it may be advisable to make a more complete evaluation of the report.

Thank you for the opportunity to make comments and offer suggestions.

Claude O. Geiger
Claude O. Geiger

Responses to U.S.G.S.

98) As discussed in response 81, these are projected water use figures in 1978 from Canada and are not used in the modeling at all. The mean flows have been added as discussed in response 78. Tributaries to the West Fork are included.

United States Department of Agriculture

Soil Conservation Service

P.O. Box 970
Bozeman, MT
59715

ENVIRONMENTAL PROTECTION AGENCY
OCT 16 1980
MONTANA OFFICE

October 1980

Gene Taylor
Environmental Protection Agency
Federal Building, Drawer 10096
301 South Park
Helena, MT 59601

Dear Mr. Taylor:

We have the following comments to offer on the Draft Environmental Impact Statement for the Impact of Canadian Power Plant Development and Flow Apportionment on the Poplar River Basin.

99) 1. Page 28, first paragraph. The total water requirement for gravity or pump irrigation was estimated at 7.7 inches. It should be further explained that this is for one irrigation only, and not the needs for the entire growing season.

100) 2. Page 30, first paragraph. It may be worth mentioning that although there is little federally-owned land in Daniels County, there is a considerable amount of state-owned land.

101) 3. Page 33, third paragraph. Safflower and sunflower are two important crops in the Daniels County area, and that may need mentioning.

102) 4. Page 46, second paragraph. Mercuric Acetone is no longer widely used in the United States as a fungicide for treatment of wheat seeds as stated here.

103) 5. Page 106, last paragraph. The assumption of an overall 65% irrigation efficiency (including both conveyance and field efficiency) appears quite high unless the entire conveyance, delivery to field and to sprinklers, is in concrete lined ditches, canals or pipelines. Any open, unlined conveyance ditches would reduce this efficiency.

104) 6. Page 107, Discussion of Irrigation Requirements. A range of about 2 to 3 acre feet of diverted water is shown to be needed for alfalfa in the area, depending on whose figures you wish to use. After the figures are given, it is stated that the Soil Conservation Service approach is more reasonable than those made by others. It is not clear, however, which volumes are predicted by the Soil Conservation Service. This needs to be cleared up. It should also be made clear that the 63% efficiency used is only for a sprinkler and pipeline conveyance system, and not open, unlined conveyance ditches such as flood systems.

Responses to Soil Conservation Service

99) After 7.7 inches "per irrigation application" has been added to the text.

100) Sentence was added giving percent of State owned land in Daniels County as 23.9 percent (Table A-2.2). Location of these lands was shown in Figure A-2.1 of the Appendix.

101) After "winter wheat", "safflower, sunflower" has been added to the text.

102) In the text "is widely" was changed to "has been used". After "basin" the following sentences have been added to the text. "This material can no longer be manufactured but existing supplies can be used up. Other sources of the mercury could be domestic sewage, dewatering of the coal seams, power transmission facilities submerged by Cookson Reservoir and an abandoned waste dump near Cookson Reservoir (Testimony at Public Hearing, 1980). A detailed analysis of this problem is needed and should be undertaken. This would require field sampling of the reservoir, river, and ground water which is outside the scope of this EIS".

103) The efficiency of 65 percent was based on the efficiency estimates for sprinkler irrigation by the Poplar River Task Force (1976) and is reasonable.

104) Because EPA used essentially the same method as the SCS does for estimating crop water requirements this comment is superfluous and has been deleted. Sentence on p. 107 of DEIS changed to read "the field and conveyance efficiency for sprinkler irrigation of 65 percent".

105) 7. Page 147, Spreader Dike or Level Border Irrigation. These two types of systems should not be confused. Spreader dikes or waterspreading systems (like those used in this area) generally provide only one good flooding per year, which may apply up to 10-12" of water to fill the soil profile. Spring run-off flows are generally used because of lack of available water in intermittent streams or poor quality water which is not usable for late season irrigation. Production from alfalfa, for example, from these systems, may be only one cutting per year (2 to 3 tons/acre). Level border irrigation is a much more intensive system, which may require land leveling and intensive management and expense to operate. They are designed where a dependable water supply is available for the entire growing season. They are generally found in the southwestern United States where much more intensive and productive types of agriculture are found.

It should not be assumed that the spreader dike (waterspreading) type of irrigation in this area could be converted to level border irrigation.

106) 8. Pages 147-148, Flood or Furrow Irrigation. The second method of irrigation water management called cut-back furrow, or flood irrigation, is theoretically a good method of irrigation. To realistically talk about using this type of system generally necessitates using some type of automation. This would be a good goal to work towards, but may be a long time coming to this area due to types of income producing crops.

Sprinkler Irrigation. An 80 to 90 percent range of application efficiency appears to be quite high for this area. 70-75% may be more realistic.

107) 9. Page 196, Universal Soil Loss Equation. This procedure is a gross misuse of the universal soil loss equation. Soil loss predicted by the USLE is that soil moved off a particular field slope. In most places, part of the sediment produced on the slope is deposited at the toe of that slope, along field boundaries, and in terrace channels or other depressions. USLE does not account for this deposition. To apply the USLE for an entire watershed using average values for the factors is also a misuse of the equation. The Soil Conservation Service uses R values of 20-30 for this area. Unless there are conservation practices of terracing, contouring, etc., applied, the P value should be 1.0. Therefore, the P value used looks to be low. To use a C value of .13 for spring wheat - fallow cropping sequence, there would have to be over 1,500 lbs of residue on or near the surface after 5 summer fallow operations. A C value of .23 may be more realistic.

108) 10. Much of the irrigation discussion is based on a reference of Evans, et al (1978). This reference is an evaluation of irrigation methods for salinity control in Grand Valley, Colorado. To compare the analysis of

irrigation methods, etc., from this study to the Poplar River area may be misleading.

Sincerely,

for Van K Haderlie
State Conservationist

cc:
Carroll M. Hamon, Staff Director, Missouri River Basin Commission, Omaha, NE

Responses to Soil Conservation Service

105) We did not intend to suggest that the type of irrigation be changed. We do suggest that efficiencies can be improved through better management of existing systems. Better management of spreader dike systems leads toward the level border configuration.

106) Change noted.

107) In applying the Universal Soil Loss Equation (USLE)deposition was accounted for by using a sediment delivery ratio. The USLE is often applied to heterogeneous basins (Williams, 1975). To do this the basin should be broken down by crop type, practice, soils, etc. In the absence of such detailed data and considering spring wheat and other small grains to be the dominant crops (in fact they account for about 95 percent of the planting) we simplified the USLE calculation. Using Haderlie's suggested values for local conditions P = 0.8, R = 25, C = .23 for wheat and small grains and C = .02 for alfalfa) the annual soil loss per acre is about 0.26 ton/acre. Applying the sediment delivery ratio of 0.23 gives 0.03 tons/acre delivered to the East Fork. This is in contrast to the 0.024 predicted previously. Changes involving the results of this calculation have been made in the text.

108) The references to the report under consideration were made primarily in the discussion of mitigative measures for salinity control, thus, the report was used only in a qualitative sense.

State of Montana
Office of The Lieutenant Governor
Helena 59601

TED SCHWINDEN
LIEUTENANT GOVERNOR

October 20, 1980

ENVIRONMENTAL PROTECTION AGENCY
OCT 21 1980
MONTANA OFFICE

Mr. Ivan Dodson, Director
Environmental Protection Agency
Federal Building, Drawer 10096
301 South Park
Helena, MT 59601

Dear Mr. Dodson:

The following comments and attached agency documents represent the response of the State of Montana concerning the draft Environmental Impact Statement on the impact of the Canadian Power Plant Development and the Flow Apportionment on the Poplar River Basin. I commend EPA for extending the comment period on this extremely technical and complex public document to provide for a thorough public analysis. Montana's attached comments represent not only an analysis of the technical air and water impacts, but also a genuine concern for the social and economic impacts that my occur. The quality of life and protection of our agricultural industry in Montana cannot be overlooked or considered insignificant.

The State of Montana has been closely monitoring the progress of the Saskatchewan Power Corporation (SPC) power plants since the fall of 1974. We have testified before the International Joint Commission (IJC) on several occasions relative to the SPC project. We are currently engaged in a comprehensive air and water quality and water quantity monitoring program and data exchange agreement with the Canadians.

109) In 1977, the Montana Legislature passed a resolution establishing a state policy that the SPC power plants should not violate federal or state pollution standards; that the Saskatchewan government should install control technology on the plants; and that transboundary impact matters should be referred to the IJC. This policy remains in effect today.

110) In addition to the attached agency comments, three significant areas of the draft appear to be inadequate. The impacts of Cookson Reservoir on the Poplar River Drainage, particularly the loss of the spring "flushing phenomena", and the concentration of chemicals in the reservoir, are not addressed. Second, the potential sources of mercury contamination have not been sufficiently identified. Finally, the potential impacts of acid

---

rain on crops, fisheries and public health have not been appropriately reviewed.

Considering the State of Montana's involvement in this project and its continuing concern for the health and welfare of the local residents, we trust that you will give serious consideration to our comments. We thank you for this extended opportunity to comment, and anticipate the final EIS will incorporate our concerns and comments.

Sincerely,

Ted

TED SCHWINDEN
Lieutenant Governor

Responses to State of Montana

109) A discussion of the status of the U.S.-Canada Air Quality Treaty has been added to Chapter 2.

110) The EPA originally directed that the EIS analyze impacts of flow apportionment and power plant operation, not reservoir construction. The loss of spring flows is discussed in the water quantity and the biological section and a discussion has been added to the water quality section. A general discussion of the flushing phenomenon has been added to the summary.

The addition of chemicals to the reservoir and river was included in the water quality model and is described in detail in Appendix D. Identification of mercury sources requires field work and was outside the scope of this EIS. (See response 102). The potential for acid rain has been analyzed. The text has been expanded to show why this is expected to be a minimal impact in the Poplar Basin.

EXECUTIVE SUMMARY OF COMMENTS
POPLAR RIVER DRAFT ENVIRONMENTAL IMPACT STATEMENT

presented by
Water Resources Division

The relative importance of irrigation in the Poplar River basin became a sensitive issue early in these international proceedings. Whether it should or should not have become an issue is no longer relevant. The merits of a multimillion dollar thermal generating plant or the merits of a half million acres of dry land crops overwhelm the merits of irrigating approximately 3500 acres of a very restricted variety of crops. Nevertheless, the practice of irrigating crops provides a livelihood to a handful of farmers in the basin. Its importance to them as individuals should not be diminished or overlooked. Yet, numerous statements are made in the EIS that either directly or indirectly serve to do just that.

Exclusive of predicted air quality impacts, the operation of the plant and its ancillary facilities near Coronach will almost certainly impact irrigation more than any other use. Therefore, the following concerns are expressed.

Roughly three fourths of the total volume of surface water that passes through the Poplar River basin in an average year does so during a rather short lived runoff period each spring. Although water quality records preceding the impoundment of water on the East Fork are meager, there is adequate evidence in support of the view that the quality of the freshet has been good.

It is not uncommon to observe at any of the boundary stations, measurements of total dissolved solids (TDS) to be less than 400 mg/l or measurements of dissolved boron to be less than 1.0 mg/l during the runoff. Realization of this is particularly important to any party that would desire to store water for the purpose of irrigating. It is equally important to those who irrigate already, requiring water of a satisfactory quality as to leach salts out of the root zone.

As it stands, there is no objective being recommended to protect
the historically good quality of the freshet and there is virtually no
110A) mention of its importance in the EIS. In fact, judging from various
statements in it, one would be led to believe that the quality of water
in the basin is always poor. If a flow weighted average value were to
be calculated for parameters such as TDS and boron, it is likely that one
would not conclude so readily that the water quality is poor.

Soon, the plant will begin igniting coal and generating electricity.
111) The Saskatchewan Power Corporation may, if it so chooses, operate in such
a manner that each spring a year's accumulation of compounds and elements
could be "rinsed out".

The most logical solution is twofold. First, more extensive water
112) quality monitoring is necessary at all boundary stations during the period
of runoff. Second, the state should seek to have established objectives
to be met at the international boundary during the runoff. The objectives
113) should be aimed principally at protecting against elevated TDS and boron
concentrations.

The operation of a single 300 MW generating unit may prove to be
insignificant. There should be concern, however, that the addition of
a second, third or fourth unit might produce significantly adverse impacts
114) in this regard. But, such impacts could go unrecognized until the concepts
advanced here are accepted.

Responses to Montana Water Resources Division

110A) A discussion of impacts due to reduced spring runoff was discussed on page 121 of the DEIS. A flow-weighted average is not meaningful for describing the quality in the summer when the most critical conditions occur. The water quality section of Chapter 4 has been expanded to discuss seasonal differences.

111) This is unlikely if a release schedule such as specified in the apportionment with the large release spread out over the irrigation season is followed. Any spill in the spring would be comprised mostly of runoff which would improve reservoir quality. In addition, much of the chemical input is from the ash lagoons which will not be discharged to the reservoir under the planned mode of operation of SPC.

112) The water quality monitoring program being developed by Montana and Canada is mentioned and recommended in the EIS.

113) The EPA did not direct that numerical quality objectives be determined or analyzed. The IJC was responsible for developing such objectives. A discussion of how the IJC recommended objectives compare to the scenarios analyzed has been added to Chapter 3.

114) The impacts of adding power plant units has been clearly shown by the modeling scenarios.

TECHNICAL COMMENTS
POPLAR RIVER DRAFT ENVIRONMENTAL IMPACT STATEMENT

presented by
Water Resources Division

Section 1.1 Water Quantity Impacts (Summary)

115) Paragraph 3 of Page 1: The statements regarding the apportionment of flows according to the recommended apportionment schedule are incorrect.

The apportionment schedule calls for an equal sharing of the total natural flow of the West Fork as measured at the international boundary. The flow of any of its tributaries shall not be depleted by more than 60 percent (presumably by Canada). Therefore, the United States would be entitled to not less than 50 percent of the West Fork and not less than 40 percent of any of its tributaries.

Furthermore, the United States would receive not less than 60 percent of the total natural flow of the Middle Fork, as measured at the international boundary.

The statement is made that flows on the East Fork will be made up of a continuous release from the reservoir of 1 to 3 cfs It would be appropriate to mention also that demand releases will augment flows and

116) that the figures 1 to 3 cfs are minimum flow requirements. There will be flows in excess of 1 to 3 cfs, particularly during, but not limited to, spring runoff.

Repeatedly, throughout the manuscript, the 300 MW generating units

117) are referred to as power plants. There is one power plant at Coronach and it is anticipated that there will eventually be two, three or four

Responses to Montana Water Resources Division

115) The summary incorrectly stated that the flow on the Middle Fork would be reduced by 60 percent. The correct value of a 40 percent reduction was used in the modeling studies and analysis of impacts (see Table 3.2-1).

116) In reality the 1 to 3 cfs on the East Fork is a minimum. Additional water was included in the modeling according to the specified schedule of demand releases and spring runoff if the Cookson Reservoir was full. The summary has been expanded to explain the East Fork flows in detail.

117) Test has been changed to "units".

units in place.

118) Paragraph 1 of Page 2: The word irregardless conveys a double negative meaning. Its use, as such, is not acceptable unless the intent is clearly meant to be humorous.

119) Paragraph 2 of Page 2: What's wrong with simply winter habitat for game fish? Also, the last sentence should probably not refer exclusively to decreased duck production; rather, decreased waterfowl production in general.

120) Section 1.2 Water Quality Impacts (Summary)

Paragraph 6 of Page 2: We recommend that the statement "March to May flow" be expanded to "March 1 through May 31 flow".

121) General: We suggest that a statement be added to this section, particularly in view of the statements made in the last paragraph of the section. The statement to be added should discuss briefly the various mitigation alternatives that have been proposed by the Saskatchewan Power Corporation, such as the proposal to divert Middle Fork water into the East Fork at a point downstream from the dam.

Section 3.2 Flow Related Alternatives

122) Paragraphs 3 and 4 of Page 13: We find these accounts to be very difficult to understand. Does the discussion beginning in the fourth paragraph assume that one, two, three or four units would be in operation? Perhaps another table or a more careful, more explanatory discussion would be an improvement. The confusion regarding the number of operating units assumed carries forth also to paragraphs 1 and 2 on page 15.

123) Paragraph 2 of Page 16: Reference to the demand releases as "one time releases" is misleading. We understand that the demand releases, once agreed upon and initiated, would be available to the United States

Responses to Montana Water Resources Division

118) **The word "irregardless" has been deleted. The original intent was to say that after full flow apportionment all the acreage could not be irrigated every year even with the proposed reservoirs.**

119) **Winter habitat would convey the same meaning as overwintering habitat so text has been changed.**

120) **The text intended to mean March through May flow and has been changed.**

121) **This mitigation measure has not been agreed to by SPC. It is unacceptable to EPA because impacts would result from decreased flows on the Middle Fork and from construction of the diversion system. Dilution of poor quality water is not acceptable to EPA as a means of meeting water quality standards.**

122) **Table F-2 from the appendix has been moved to this section. The number of power plant units is one in 1975 and four in 2000. This is not important since flows on the East Fork are determined by the same release schedule.**

123) **The term "one time release" was used to distinguish it from the continuous releases of 1 to 3 cfs according to the proposed apportionment. The text has been changed to "scheduled release" since the flow would probably be discharged only at stated times. The schedule in the model per IJC and EPA request was during the irrigation season (Table 5.2-1) based on Middle Fork flow. Suggestions are made in the EIS to change this schedule to aid other uses as well as irrigation.**

upon request and at any time between June 1 and May 31. It is logical to assume that the concept of demand releases was developed in order to satisfy more than one requirement.

Based upon flow records dating back to 1931, demand releases should be available to the United States according to the following schedule:

Volume of Release	Frequency
1000 acre feet	3 years in 10
500 acre feet	5 years in 10
300 acre feet	2 years in 10

Section 3.3 Water Quality

Paragraph 4 of Page 17: The discussion of modifications in the operation of the ash lagoons refers to a decrease of TDS concentration in
124) the East Fork by 10 percent. To which condition is such a decrease compared? Likewise, it is not clear to us which condition is the baseline for a comparison in the subsequent discussion of reduced boron levels.

Table 3.3-2 on Page 19: The word adsorption in misspelled in the heading.

Section 4.3 Land Use

The importance of irrigation in this basin has been an extremely sensitive issue throughout these technical investigations and international proceedings. Regardless of the relative insignificance of irrigation, as compared to dry land farming, the very livelihood of a significant number of farmers depends heavily upon the availability and quality of irrigation water.

It is our position that statements such as those made in the last
125) sentence of Paragraph 5 are not inocuous, as perhaps intended. In fact,

Responses to Montana Water Resources Division

124) Both the TDS and boron concentration comparisons were made using the model results for scenario 4A (with ash seepage to reservoir, one 300 MW unit and 1975 water uses) and scenario 2B (no decant to reservoir, one unit and 1975 water uses).

125) Chapter 4 describes 1975 conditons. While irrigation is vital to farmers who practice irrigation, only a small percentage of the crop acreage is presently irrigated. The major issue is whether future increases can be made in irrigated acreage given the apportionment and water quality constraints. A discussion has been added to the economic impacts section discussing impacts on irrigated farmers.

such statements carry with them the potential to diminish the importance of irrigation in the Poplar River basin.

Section 4.5 Water Quality

Paragraph 3 (excluding list of parameters) of Page 46: It is stated 126) that the TDS values, as measured in the East Fork near the international boundary in 1975, fall in the range of 1050 to 1750 mg/l.

Chemical analyses reported by the U.S. Geological Survey for the period of December, 1974 through September, 1975 show TDS values for the East Fork at the international boundary fell in a range of 689 to 1480 mg/l. It is misleading and erroneous to infer that the water in the East Fork is necessarily of a poor quality. It is at times poor in quality; however, during runoff, when the overwhelming bulk of the stream's annual discharge historically passed through the basin, the water's quality was in fact good. This realization is vital to the Fort Peck tribes and their plans to store that runoff. It is equally vital to any irrigator in the basin, who must count on water of a good quality for his first one or two applications in the spring, since it is not often possible in the autumn to leach out the accumulation of salts in the soil.

Records of subsequent years support our contention that TDS values are not as high as the values that are often reported out of context. From October, 1975 to September, 1976, TDS values, as measured in the East Fork at the international boundary, exceeded 1000 mg/l only in November and December. In most remaining months, measurements fell in the range of 850 to 950 mg/l, but in March and April, TDS values were as low as 100 to 200 mg/l.

With these data in mind, we urge against any statement that leads to the conclusion that the quality of water is generally poor. A flow weighted average of TDS values shows the opposite to be true. Yet,

Responses to Montana Water Resources Division

126) These values are mean values. Water with TDS greater than 500 mg/l cannot be classed as "good" for use as a public water supply since this is a violation of the secondary drinking water standards for which the water is also used. However, 500 mg/l water would be acceptable for irrigation. The quality was better during spring runoff prior to the reservoir than at other times of the year. The decrease in runoff to the river due to the impoundment does result in higher TDS concentrations (Karp, 1979). The additional increase after impoundment in TDS concentrations due to operation of one 300 MW unit is small. A discussion of seasonal differences has been added to Chapter 4.

nowhere in the EIS, as far as we have been able to ascertain, has this point been discussed.

The same point can be raised with respect to boron values. The U.S. Geological Survey water quality records of 1975 report a slightly lower range of boron in the water of the East Fork (2.3-3.0 mg/1) than is reported on Page 46 (2.5-3.7 mg/1). In the case of boron in the irrigation water, the presence of 4.0 mg/1 over an extended period might very well reduce the yield of a crop to the extent that it becomes economically unsound to irrigate it. While the reduction in yield, as expressed in terms of the entire county, may show a very small change, that statistic may affect a few individuals to the extent that they might no longer have the option of growing a particular crop. 127)

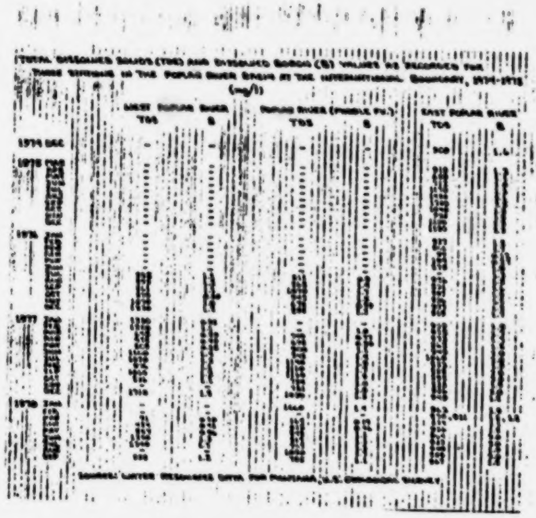
128) Paragraphs 1 and 2 of Page 47: We again argue with the TDS values reported for the Middle Fork and the main stem of the Poplar River. What is the source of those values reported? Water quality records of the year 1976 show TDS values as low as 511 mg/1 in July and 865 mg/1 in August on the Middle Fork. On the main stem, a TDS value of 234 mg/1 was measured in July and 872 mg/1 in August.

Granted, these fragmented TDS values can be misconstrued; however, we reiterate that we see written in the EIS a slanted interpretation of two very crucial parameters, total dissolved solids and boron. The attached table summarizes all of the recent data available for TDS and boron as recorded in the U.S. Geological Survey annual publication, Water Resources Data for Montana.

129) Table 4.6-1 on Page 58: Manternach Coulee is mispelled.

Section 5.2.1.3 Water Uses

Paragraph 4 of Page 107 (second to last line): . . . . a 10 percent chance that . . .



TOTAL DISSOLVED SOLIDS (TDS) AND DISSOLVED BORON (B) VALUES AS RECORDED FOR THREE STREAMS IN THE POPLAR RIVER BASIN AT THE INTERNATIONAL BOUNDARY, 1974-1978 (mg/l)

SOURCE: WATER RESOURCES DATA FOR MONTANA, U.S. GEOLOGICAL SURVEY

Responses to Montana Water Resources Division

127) Boron data were obtained from the USGS (Water Resources Data for Montana 1975) and from the Montana State Water Quality Bureau sampling network stations. Our analysis in Chapter 5 shows that crop reductions due to boron are less severe than reductions due to salinity. Yield decreases were for crops irrigated with Poplar River water only, not for the entire county.

128) The water quality data discussed here and throughout Chapter 4 are for 1975 and are summarized in Appendix A of the EIS. The data were collected in 1975 by the USGS and Montana State Water Quality Bureau. The range of data points has been added to better describe the quality. Data discussed in this letter is post-impoundment data.

129) Text corrected.

Section 5.2.3.2 Uses Dependent on Spring Water

130) General: This section may be an appropriate one to include some mention of the fact that the spring freshet provides irrigators with an opportunity to leach salts out of the soil. If this is not the appropriate section to make the point, then it should be discussed in a previous section on water quality.

Section 5.2.3.2

Paragraph 3 of Page 122: ". . . with little or no irrigation in August and September."

Although there may be relatively little irrigation in the basin,
131) those who irrigate often pump water out of deep pools in the late summer, even when it appears there is zero flow. Those who practice this method, proper or not, are, for all practical purposes, pumping groundwater. Both the United States and Canada contingent on the Water Uses and Water Quality Objectives Committee observed this practice and were in fact informed at a public meeting that this practice is necessary to some farmers.

Section 5.3.2.1 Boron Impacts on Crops

Paragraph 2 of Page 129: "The crops studied were alfalfa, wheat,
132) barley, and oats, although at present the latter two crops are not usually irrigated."

Once again, a seemingly inocuous statement actually has the effect of leading the reader to believe that irrigated barley is not so important in this basin.

Ask Evan Benson, Rick Anderson, Ann Lund, Sherman Johnson, Palmer Teigen, Tom Davis, Ken Lee, Darrell Fladager or Barry Handy how important barley is as a cover crop or as a cash crop when the proper combination of good management and water make malting barley possible. We believe that in every year at least a few of those persons mentioned, and probably others, irrigate barley.

Responses to Montana Water Resources Deivision

130) A discussion of spring runoff quality has been added to Chapter 5.

131) The model allowed for irrigation diversions directly from the river which in these months could not be fully met. If deep pools filled by ground water are available, then these demands or, at least a portion of them, could be met.

132) The last part of this sentence has been deleted. However, it is important in estimating economic impacts to know which crops are irrigated and how much. A discussion in the economics section has been added stating that reduction in crop yield may result in significant losses for the farmers presently using irrigation water from the Poplar River.

133) On page 203 of the Appendix, the conversion factor is too high. Proper conversion factors are given on page 55 of Appendix A of the International Poplar River Water Quality Study. (The result is that the TOS values given in this draft EIS are too high by about 15-20%).

134) On page 14 of the EIS report, the tabular data is not extracted accurately from the cited reference. The boron values for the lower basin were determined differently from the upper basin and the values of zero were assigned to those samples that were not analyzed.

Responses to Montana Water Resources Division

133) This error has been corrected.

134) This has been discussed in response to other comments. (See comments of W. Draper).

Three Corners Boundary Association
P.O. Box 676·Scobey, Mt 59263

80 SEP 22 P3:36

25165

Sept. 17, 1980

Roger L. Williams
Regional Administrator, Region 8
Suite 103, 1860 Lincoln St.
Denver, CO 80295

Dear Mr. Williams,

I am writing on behalf of the Three Corners Boundary Association, a group of farmers, ranchers and other citizens in Northeast Montana.

Our first review of the Draft Environmental Impact Statement on the Poplar River Basin (EPA 908/5-80-003) has done little to restore our faith in the government processes designed to protect our environment.

135) First, there has been no general notice of the September 23, 1980 Public Hearing on the DEIS in the local media, or anywhere else to our knowledge. Such notice would have been appropriate under section1506-6(b)3 of the CEQ regulations implementing NEPA.

136) Second, we object to the fact that the language of the DEIS is unreadable and almost useless to the general public. Examples abound. This is in direct conflict with 1502.8 of the above cited regulations.

Third, and most important, the DEIS completely fails to mention the 1909 Boundary Waters Treaty, which is of central importance in the Water Apportionment decision the EIS was intended to address.

The U.S. State Department is responsible for preserving the integrity
137) of the Treaty, which says, in part, that "waters flowing across the boundary shall not be polluted on either side to the injury of health or property on the other. The lack of even a reference to the treaty in the EPA document shows neglect of the central issue in the discussion.

(More)

AN AFFILIATE OF THE NORTHERN PLAINS RESOURCE COUNCIL

[illegible]-FW
[illegible]-RA
DRA
MO
[illegible]-3E

138) Will the effect of the recommended International Apportionment of the waters of the Poplar River violate Article IV of the Treaty, or will it not? If it will, what alternatives are available?

Your prompt attention to this matter will be appreciated.

Yours truly,

Lee Humbert

Lee Humbert
Chairman, TCBA

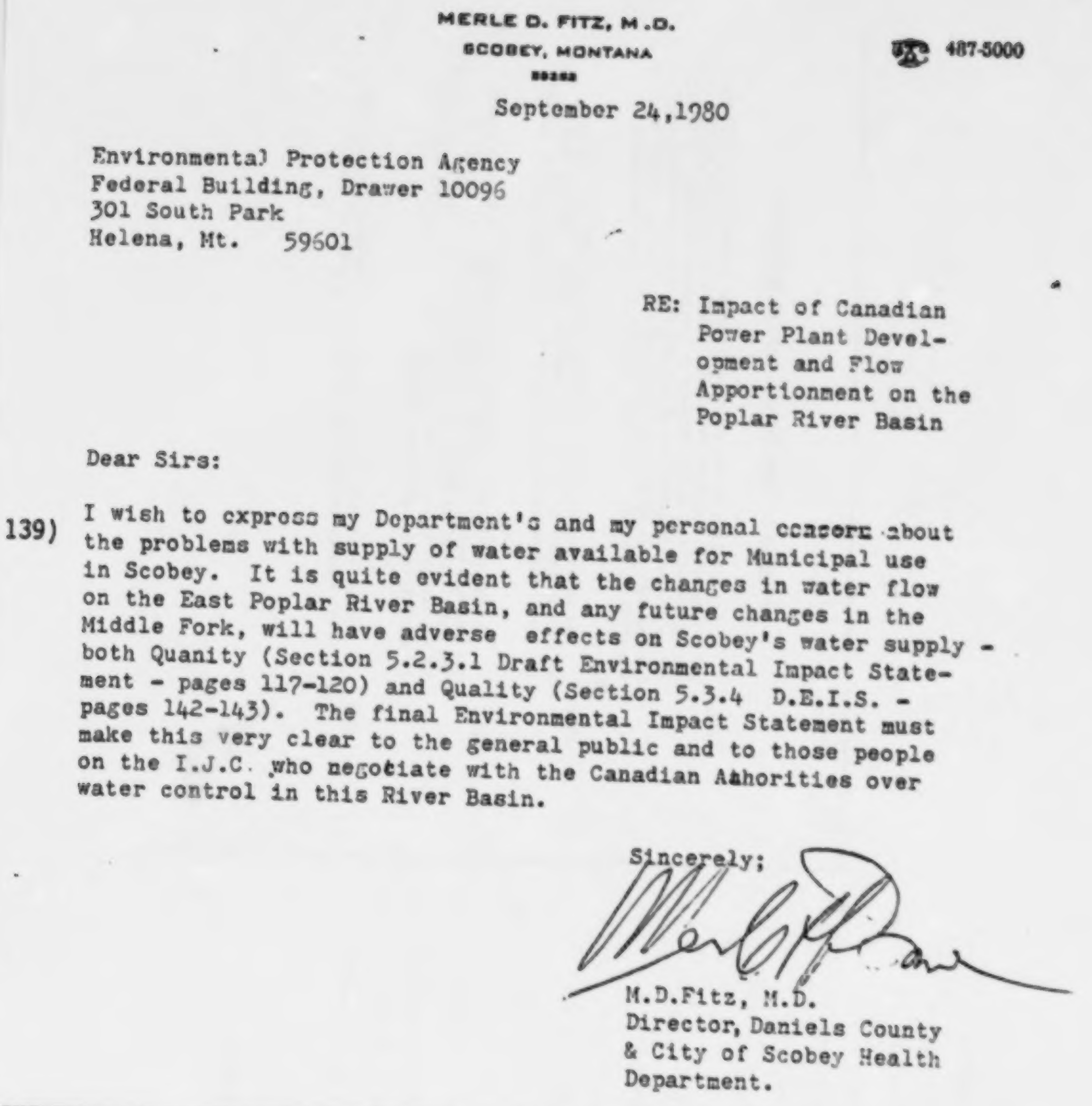
Responses to Three Corners Boundary Association

135) A legal notice of the public hearing on September 23, 1980 was put in the local newspaper in Scobey by the EPA as stated by the EPA Hearing Officer Wilkes McClave at the Public Hearing. "Also, a notice of the time and place of the meeting accompanied each draft EIS that was sent to each individual and organization listed on the front of the EIS. This list includes all area newspapers.

136) We agree that parts of the draft EIS were difficult to read. We have attempted to remedy this problem in the final EIS though we cannot exclude technical discussions of a highly complex subject.

137) We agree with the importance of the Treaty. A description of the Boundary Waters Treaty of 1909 has been added to Chapter 2. The objective of the EIS is to identify potential impacts. It would be the responsibility of the injured parties to identify violations of the Treaty and take legal remedies.

138) Mitigation measures of air quality, irrigation, and fish and wildlife impacts are discussed in Chapter 3 and 5 of the EIS.



MO-1

MERLE D. FITZ, M.D.
SCOBEY, MONTANA
[illegible]

☎ 487-5000

September 24,1980

Environmental Protection Agency
Federal Building, Drawer 10096
301 South Park
Helena, Mt. 59601

RE: Impact of Canadian Power Plant Development and Flow Apportionment on the Poplar River Basin

Dear Sirs:

139) I wish to express my Department's and my personal concern about the problems with supply of water available for Municipal use in Scobey. It is quite evident that the changes in water flow on the East Poplar River Basin, and any future changes in the Middle Fork, will have adverse effects on Scobey's water supply - both Quanity (Section 5.2.3.1 Draft Environmental Impact Statement - pages 117-120) and Quality (Section 5.3.4 D.E.I.S. - pages 142-143). The final Environmental Impact Statement must make this very clear to the general public and to those people on the I.J.C. who negotiate with the Canadian Authorities over water control in this River Basin.

Sincerely;

M.D.Fitz, M.D.
Director, Daniels County
& City of Scobey Health
Department.

Response to City of Scobey Health Department

139) The section on effects on the municipal water supply of Scobey in the summary has been expanded.

Missouri River Basin Commission

Millard W. Hall
Chairman
Warren R. Neufeld, South Dakota
Vice Chairman

Suite 403 • 10050 Regency Circle • Omaha, Nebraska 68114

"A Presidential State-Federal River Basin Commission"

September 26, 1980

Mr. Roger L. Williams
Regional Administrator
Region VIII, U.S. Environmental
Protection Agency
Federal Building
Helena, Montana 59601

Dear Mr. Williams:

The MRBC staff has reviewed a copy of the Draft Environmental Impact Statement (DEIS) and Appendix on "Impact of Canadian Power Plant Development and Flow Apportionment of the Poplar River Basin." The following general comments and attached specific comments are offered for your consideration.

General Comments

Overall the DEIS, as written, is extremely difficult to understand. Throughout the document, hypothetical environmental conditions are discussed in detail, which are predicated on the implementation of various flow apportionments. These projected environmental conditions are then interwoven with discussions of impacts associated with proposed power plant development and detailed discussions of water demands for future irrigation development in the U.S portion of the Poplar River Basin.

140) The Draft EIS would be much easier to follow if the power plant development and the flow apportionment questions were discussed separately. It is suggested that the EIS analysis focus on an evaluation of alternative flow apportionments rather than emphasizing the analysis of the impacts associated with a recommended apportionment that apparently has been developed without the benefit of detailed EIS studies. The detailed discussions of projected irrigation developments and air quality impacts also tend to overshadow the issue of flow apportionment.

141) Another general comment is the inconsistent use of abbreviations and terms. For example, the capacity of the power plants is shown as "MWe" in several places while in others it is shown as "MW," the more conventional abbreviation.

COMMISSION MEMBERS

Colorado, Iowa; Kansas, Minnesota; Missouri; Montana; Nebraska; North Dakota; South Dakota; Wyoming; Department of Agriculture; Department of the Army; Department of Commerce; Department of Energy; Environmental Protection Agency; Federal Emergency Management Agency; Department of Health and Human Services; Department of Housing and Urban Development; Department of the Interior; Department of Transportation; Yellowstone River Compact Commission, Big Blue River Compact Administration.

---

142) Also, the verb tense used throughout the DEIS makes it difficult to distinguish current conditions from those which are projected. For example, page 2, the first paragraph, the third line infers that the reservoirs are in place; but other references indicate that these are potential developments.

Thank you for the opportunity to review this DEIS. I trust that these comments and those which are attached will be helpful in finalizing the EIS.

Sincerely,

Carroll M. Hamon

Carroll M. Hamon
Staff Director

MMH/sck

Attachment

cc: John E. Acord, MRBC Member
Gary Frits, MRBC Alternate

Responses to Missouri River Basin Commission

140) Text intended to say irrigated acreage is expected to increase substantially after construction of two proposed reservoirs.

141) Because of the number of flow apportionment alternatives, it was decided that we should describe in detail the impacts for the recommended apportionment of the IJC in the main body and to discuss differences in impact for the other alternatives. It was also initially decided to present an integrated assessment of all impacts of the flow apportionment and power plant development.

142) The abbreviation for power plant capacity has been changed to "MW" throughout the report.

SPECIFIC COMMENTS

on the

DRAFT ENVIRONMENTAL IMPACT STATEMENT ON IMPACT OF CANADIAN POWER PLANT DEVELOPMENT AND FLOW APPORTIONMENT ON THE POPLAR RIVER BASIN

The following comments are principally editorial and are part of the Commission's September 26, 1980, response on the DEIS, "Impact of Canadian Power Development and Flow Apportionment on the Popular River Basin":

143) The pagination of the DEIS summary is incorrect.

On the third page of the DEIS summary the following corrections should be made.

- Under congressional, Marlenee is misspelled.
- Under the Montana listing, "Old West Regional Commission" is not a part of Montana government; it is within the Department of Commerce.
- Under Department of the Interior, "Bureau of Outdoor Recreation" should be deleted and replaced by Heritage Conservation and Recreation Service, which is shown. The "Bureau of Reclamation" should be changed to Water and Power Resources Service.

144) On the fourth page of the DEIS summary the "Missouri River Basin Commission" is shown incorrectly as part of the U.S. Department of the Interior. The Commission should be listed as a joint State-Federal entity.

145) Page 5, second paragraph, second line. The phrase "of the Souris Red River Basin," should be deleted and substitute of the Missouri River Basin.

Page 9, last paragraph, second line. The acronym "ESP" should be defined.

146) Page 12, last paragraph. This paragraph discusses 60 and 90 percent conditions and indicates that if SO_2 control was increased to 90 percent, all class I standards would be met. Is there an interim point between 60 and 90 percent where standards might be met? If so, this point should be

Responses to Missouri River Basin Commission

143) Corrections noted.

144) Change was made.

145) "ESP" stands for electrostatic precipitator. This is spelled out in the text.

146) Based on the modeling results, the Class I PSD standard for maximum 24-hour SO_2 concentrations cannot be satisfied in the northern portion of the Fort Peck Indian Reservation with 60 percent sulfur oxide (SO_2) control of stack emissions. As indicated in Table 3.1-2, the predicted SO_2 concentrations exceed the Class I standards by a factor of four. Therefore, 75 percent control of SO_2 emissions from the stack would result in compliance with the standard. However, to attain this level of SO_2 emission control, flue-gas desulfurization procedures such as alkali scrubbing (removal efficiency of 80% or more) must be implemented.

identified and discussed.

147) Page 33, third paragraph, third sentence. The sentence should be rewritten to reflect that unused fallow areas conserve water for the next season's crop, not for crops planted adjacent to them.

148) Page 37, first paragraph, second line. The location should be 48° 50'. This junction is north of the West Fork bifurcation.

149) Page 59, third paragraph, second sentence. The year or period the value for angler-days refers to is unclear.

150) Page 106, last paragraph, second line. The word potential should be added ahead of "construction."

Page 107, first paragraph. This paragraph should be revised to state that these are potential reservoirs and have not been built.

151) Page 107, second paragraph, fourth line. Figure 4.5-2 showing total potential evaporation for June through September is not referred to in the text.

152) Page 107, second paragraph, seventh line. It would be more accurate to subtract growing season precipitation rather than annual used in this reference. Also what about soil moisture content at start of growing season?

153) Page 107, third paragraph, second sentence. Alfalfa is one of the first crops to "green-up" in the spring, and one of the last to stop growing in the fall. The May 30 - September 20 growth period stated in alfalfa seems too short.

154) Page 107, third paragraph, ninth line. Chance is misspelled.

155) Page 107, third paragraph, ninth line. This sentence infers that all precipitation received from June through September is effective in meeting consumptive uses. This is not accurate; a portion is lost through evaporation and runoff.

Responses to Missouri River Basin Commission

147) Sentence changed to say "conserve water for acreage planted the following year".

148) Text changed to 48 50'.

149) The period when the angler days were measured has been added.

150) Sentences were changed to "proposed construction of two reservoirs" and "proposed installation" rather than "expected installation".

151) Reference to Figure 4.5-2 is deleted.

152) The sentence in question is in error. Morrison-Maierle subtracted 11.0 inches of natural rainfall from their calculated consumptive use of 33.0 inches. This 11.0 inches is not the annual precipitation. The sentence will be changed to read, "Subtracting a precipitation depth of 11.0 inches and dividing by ...". Apparently Morrison-Maierle did not account for initial soil water.

153) The irrigation season has been changed to May 1 through September 20.

154) Text corrected.

155) The methodology has been changed so that only "effective" precipitation is assumed to supplement soil water.

156) Page 117, last paragraph, last line. The references to "outdoor water" here and throughout the following paragraphs should be defined and explained.

157) Page 125, next-to-last sentence. This statement is not consistent with the discussion on page 59 regarding fish habitat.

158) Page 149, first paragraph. The adverse effects of energy requirements should also be described in this discussion of sprinkler irrigation.

Page 160 and 161. The discussion of costs should be made clear. The fixed investment costs should be differentiated from the annual or recurring costs.

159) Page 175, second paragraph, third line. Susceptibility is misspelled.

Page 176, last paragraph, fourth line. Precipitators is misspelled.

Page 181, third paragraph, item 3. Solubility is misspelled.

Responses to Missouri River Basin Commission

156) Sentence changed to add that outdoor water uses include lawn and garden watering, car washing, street cleaning, etc.

157) Fish habitat on the West Fork is not as good as along the East Fork and Main stem of the Poplar. Text on p. 59 expanded to discuss this observation.

158) Annual fixed and operating costs for irrigated crops have been added.

159) Typographical errors have been corrected.

Office Phones
Wolf Point 653-2353
Plentywood 765-1741
Scobey 487-5561

DISTRICT SANITARIAN
Roosevelt, Daniels and Sheridan County Health Departments
HEADQUARTERS: P.O. Box 726, Wolf Point, Montana 59201

October 16, 1980

Environmental Protection Agency
Federal Building, Drawer 10096
301 South Park
Helena, Mt. 59601

RE: Impact of Canadian Power Plant Development and Flow Apportionment on the Poplar River Basin

Dear Sirs:

I wish to express my concern over four questions that were raised in my mind while reviewing the E.P.A. Draft E.I.S. Those questions are as follows:

160) 1) Why was not the alternative of installing flue gas desulfurization equipment on the Canadian power plant considered for reducing the amount of SO_2 released into the atmosphere? (p.-9)

161) 2) What water source, other than the Poplar River, would recharge the ground water for a well located farther away from the subject river at Scobey? (p.-120)

162) 3) What mitigating measures can be implemented to control or reduce TDS concentrations and amount of SO_4 in drinking water obtained from the Poplar River? How much will they be filtered out by movement through the soils, into the ground water which is tapped for Scobey water? (p.-142)

163) 4) How far from the Canadian power plant will enough atmospheric pollution occur to cause acid rain? (p.-177)

I would certainly appreciate it if the final E.I.S. could answer the above questions more thoroughly. Also, as the Tri-County Sanitarian for Daniels, Roosevelt and Sheridan Counties, all of which may be somewhat impacted by the Coronach Power Plant, I would appreciate a copy of your final E.I.S.

Sincerely yours,

Elenore Gustafson R.S.

Elenore Gustafson, R.S.
District Sanitarian

EMG/vlk

Responses to County Health Departments

160) SO_2 control by flue gas desulfurization equipment at 60 and 90 percent control levels was considered. Results are shown in Table 3.1-1.

161) Recharge to the glacial aquifer is from the Poplar River, infiltration of direct precipitation, and some from the overlying Flaxville gravel formation to the east of Scobey.

162) Data taken at the Scobey municipal well and the East and Middle Forks of the Poplar River in 1976 (Klarich, 1978) indicate that little mitigation of TDS and SO_4 concentrations occur due to movement through the alluvium. The quality of water in the Scobey well should be somewhat better than the quality of the East Fork given in this EIS because some recharge occurs from ground water. Also, the river water is combined East and Middle Fork water not just East Fork water as shown in the model results. Treatment processes are available to remove TDS and SO_4 (e.g. ion exchange, reverse osmosis) but they are expensive.

163) The question is the subject of major research efforts both in North America and in Europe. Expected emission levels from the SPC plant will contribute SO_2 and NO_x which can result in rain with a low pH. The impact of acid rain in an area depends on the buffering capacity of the soils and surface water. As discussed on p. 171-172 and 177-180 of the DEIS, buffering capacity is high. Thus, no major impacts from acid rain are predicted.

MONTANA HISTORICAL SOCIETY
HISTORIC PRESERVATION OFFICE
225 NORTH ROBERTS STREET • (406) 449-4584 • HELENA, MONTANA 59601

August 19, 1980

Mr. Gene Taylor
Environmental Protection Agency
Federal Building, Drawer 10096
301 South Park
Helena, MT 59601

Re: Impact of Canadian Power Plant Development and Flow Apportionment on the Poplar River Basin.

Dear Mr. Taylor:

164) Thank you for the opportunity to review this Draft Environmental Impact Statement. Although the issue is not addressed within the report, it appears there will be few effects on cultural and historic properties, in Montana.

Sincerely,

Marcella Sherfy
Deputy State Historic Preservation Officer

TAF/MS/det

Response to Montana Historical Society

164) A map of historic places is presented as Figure 4.10-1. A discussion of the likelihood of effects on cultural and historic places has been added to Section 5.4.1.

ENVIRONMENTAL PROTECTION AGENCY
AUG 21 1980
MONTANA OFFICE

MORRISON-MAIERLE, INC.
CONSULTING ENGINEERS
STRUCTURAL   WATER RESOURCES   ENVIRONMENTAL   TRANSPORTATION
ENGINEERS — EARTH SCIENTISTS — PLANNERS

October 20, 1980

ENVIRONMENTAL PROTECTION AGENCY
OCT 22 1980
MONTANA OFFICE

Max Dodson
U.S. Environmental Protection Agency
Federal Building
Helena, Montana 59601

Dear Mr. Dodson:

Enclosed is a copy of comments prepared on behalf of the Fort Peck Sioux and Assiniboine Tribes respecting the Draft Environmental Impact Statement for the Poplar. These comments are the same as those delivered to you on October 17, 1980.

Sincerely,

MORRISON-MAIERLE, INC.

Mike Watson
Mike Watson

MW/dal
Encl
cc: Dave Johnson
Fort Peck Sioux & Assiniboine Tribes

P O BOX 6147 / 910 HELENA AVENUE — HELENA MONTANA 59601 — PHONE 406 442 3050

OBJECTIONS OF THE FORT PECK INDIAN TRIBES TO THE DRAFT EIS, IMPACT OF CANADIAN POWER PLANT DEVELOPMENT AND FLOW APPORTIONMENT ON THE POPLAR RIVER BASIN, PREPARED BY MORRISON-MAIERLE, INC.

165) 1. The DEIS is severely limited in its scope. The only water quality impact assessed is that resulting from uses by Canada without control of water quality at the international boundary. State Department officials have no data that permits evaluation of impacts on the United States under conditions of numeric water quality criteria at the international boundary.

The guarantee to a downstream country of water of specified quality is standard and accepted international practice. On the Colorado River the United States guarantees Mexico 1,500,000 acre-feet per year, and the U.S. has expended hundreds of millions of dollars to guarantee that the salinity of the water will not exceed 994 milligrams per liter. Recently, the International Joint Commission recommended salinity objections for the Souris River in Manitoba of. . ."an acceptable concentration of 1,000 g/m³. . . ."

Council of Environmental Quality guidelines:

> "A rigorous exploration of the environmental impacts of all reasonable alternative actions, particularly those that might enhance environmental quality or avoid some or all of the adverse environmental impacts, is essential" (40 CFR 1500.8).

While numerous sub-alternatives have been evaluated (Scenarios 4,5,6, 23, 24, 25, 26 and 27), only one alternative action by the governments of Canada and the U.S. has been presented . . . uncontrolled water quality at the international boundary with the full burden of mitigation on the United States; (See Section 5.3.5). Numeric water quality criteria at the international boundary is a highly reasonable alternative, an alternative about which the International Joint Commission (IJC) has expended considerable time and effort.

Not to include evaluation of numeric water quality criteria at the boundary is to frustrate State Department decision-makers. With respect to

Response to Morrison-Maierle

165) The option of numeric criteria was not finalized at the time of the water quality modeling and preparation of the EIS. The numeric criteria objective of 1000 mg/l or 1500 mg/l TDS has been evaluated using the appropriate scenarios. This has been added to Chapter 3 and the summary. As explained earlier, the purpose of this EIS was to evaluate flow apportionment alternatives and power plant operation on the U.S. The EIS has taken a conservative approach showing what the effects will be without water quality objectives. This can give the State Department reasons and data to press for imposing those objectives if such a course of action is selected.

the environmental consequences of entering into an agreement with Canada, the State Department has no basis to evaluate the effects of controls at the boundary. It is inappropriate for the EPA to determine that an alternative action embracing numeric criteria at the boundary is unreasonable and to, therefore, exclude that alternative action from consideration.

Additionally, CEQ guidelines require:

> ". . .agencies to assess the positive and negative effects of the proposed action as it affects both the national and international environment." (40 CFR 1500.8(3)(c))

The DEIS failed to consider any alternative that would require Canada to provide water of specified quality at the international boundary. Consequently, there was no assessment of any positive water quality effects accruing to the U.S. from numeric water quality criteria at the boundary.

166) 2. The DEIS failed to properly evaluate the property damages from water quantity reduction and water quality degradation on Fort Peck Indian water rights and irrigation development potential. In depth investigations by the Fort Peck Tribes show current crop production per acre on dry farmed lands at $77.00. Crop production would increase in value to $350.00 per acre with irrigation, a net increase of $273.00 per acre. With reservoir storage on the reservation, dependable water supply is expected to total 6,000 acre-feet less with apportionment to Canada than without apportionment. The six thousand acre-feet is sufficient to irrigate a minimum of 2,060 acres. Consequently, the reduced flow of the river would result in reduced revenues from crop production in the amount of $560,000 per year. The DEIS does not mention any annual damages stemming from reduced water supply, title to which resides in the Tribes. (See pp. 2 and 3 of "Recommended Numeric Criteria at International Boundary, Poplar River Basin" April 1979, Water Uses and Water Quality Objectives Committee, Poplar River Water Quality Board).

The DEIS speculates that water quality will decrease alfalfa yields by 15 to 21 percent, in 50 percent of the years on Fort Peck Reservation, (See p. 213, Appendix G, .1 leaching fraction). For 10,000 acres irrigated within the reservation, the resulting crop losses will be valued at $630,000 per year. For 20,000 acres the value of the losses will be $1,260,000.

167) The statement that:

> "The preceding discussion of impacts has presented the worst case situation." (DEIS, p. 165)

is clearly eroneous. The DEIS contends that the maximum possible losses in farm income in both Daniels and Roosevelt Counties will be $1,130,000 per year. More losses than given in the DEIS can be expected on the Fort Peck Indian Reservation alone. Employment losses and secondary impacts were notably absent in the DEIS.

Responses to Morrison-Maierle

166) Table 5.5-2 (P. 163 in DEIS) shows the estimated change in farmers' income that would result from the reduced water supplies under the apportionment. See response 168.

167) The wording has been changed from "worst case" to "pessimistic situation". Greater impacts could occur if all irrigated lands were damaged by TDS to the extent that no crops would grow for some period of time. It is unlikely that farmers would allow this to occur.

The loss of $1,130,000 is net income, not gross farm receipts.

168) The DEIS also assumes, implicitly, that the irrigated acreage now in production results in farm receipts of about $50 per acre. In Table 5.5-5 the "Maximum Possible Impact on Farm Income" is $1,130,000 if 22,524 presently irrigated acres were taken out of irrigation and subsequently dry farmed. It is respectfully submitted that the value of irrigation in increased crop production is a minimum $273 per acre, not $50 per acre. Therefore, if the 22,524 irrigated acres were placed in dry farms, the loss of crop value would be $6,150,000 per year.

169) In further denigrating the value of irrigation the Draft EIS claims that by year 2,000. . ."The largest absolute and percentage impacts would occur in Roosevelt County where farm income could be reduced by 6%. . ." The DEIS fails to recognize that this "maximum possible impact" would involve the destruction of 100% of the irrigated lands in the area and seriously damage numerous farms and ranches. The DEIS has not evaluated the impact on the farms involved or on the livestock industry. Costs of importing livestock feeds to the area, as experienced during the 1980 drought, would destroy the local livestock industry within several years. The DEIS further fails to consider the loss in land values, tax base and employment opportunities within the balanced irrigated and dry farm economy of Daniels and Roosevelt counties.

170) The hypothetical "maximum possible impacts" should abandoned and replaced with probable impacts. Specifically the final EIS should state:

- loss in crop values from presently irrigated acreage.
- number of farms affected.
- impact on present livestock industry from loss of hay base.
- future losses within Fort Peck Indian Reservation as summarized above.

Responses to Morrison-Maierle

168) The DEIS explicitly states that the impacts are calculated using $50/acre as the difference in net income for irrigated crops and net income for dryland farming. This was done to avoid having to make assumptions about future commodity prices as well as future prices of fram inputs.

The $50/acre figure does allow for possible increases in wheat and alfalfa prices--it is 18 percent greater than the differential of $42.50/acre estimated by Luft (1979).

Impacts are based on estimates of mean flows, not maximum irrigable acres. The variation in natural flows would not allow 22,524 acres to be irrigated in all years.

169) "Maximum possible" changed to "pessimistic". It is highly unlikely that farmers would irrigate with low quality water to a degree that might be considered "destruction" of the croplands.

The impact on the livestock industry depends upon the crops grown on the irrigated acreage. Any wheat acreage would not affect the livestock industry. Adding impacts to the livestock industry to impacts on crop yields would cause some double counting.

The experience of the 1980 drought demonstrates that the livestock sector is highly sensitive to water conditions. It is impossible to estimate how grazing lands along the Poplar might be affected by the apportionment. Subsurface irrigation is not well documented.

170) Items added to the final EIS:

a. Loss in crop values from presently irrigated acreage.

Table 5.5-2 shows the impact of the apportionment on lands irrigated in 1975.

b. Number of farms affected

In 1974 only 14 farms in Daniels County and 31 farms in Roosevelt County had irrigated acreage. (Montana Agricultural Statistics 1975). We cannot project accurately the number of farms that might be affected under future conditions. Acres of irrigated land were used to estimate the total dollar impacts.

c. Impact on present livestock industry from loss of hay base.

Table 5.5-2 shows minimal impacts in Daniels County and no impacts in Roosevelt County in 1975. Therefore, the present livestock industry may be only slightly affected.

d. Future losses within the Fort Peck Indian Reservation.

The data for Roosevelt County are a close approximation of impacts on the Fort Peck Indian Reservation.

171) 3. The DEIS presents one alternative for mitigative measures to reduce impacts of saline irrigation waters. That alternative is full mitigation by farm operators within the United States. Those operators are expected to:

- improve conveyance (p. 146)
- line on-farm conveyance (p. 146)
- alter irrigation practices (p. 146)
- switch to more effective system (p. 146)
- receive irrigation education (p. 146)
- provide greater leaching (p. 162)

No mention is made of the costs in dollars to U.S. operators. Costs should be presented. Moreover, no evaluation of impacts was provided with respect to 10, 20 and 30 percent increases in irrigation application to leach soils damaged by upstream water quality degradation. With respect to increased leaching requirement the EIS should, as a minimum, address the following:

- impact on water rights of increased diversions for leaching.
- increased fertilizer costs of unavoidable leaching of nutrients.
- increased drainage costs.
- percentage of lands that would be lost to saline seep from increased application of water.

The failure of the DEIS to consider an alternative of water quality control at the international boundary and resting the full burden of water quality mitigation on U.S. water users, leaves the document totally one-sided and of no value to Canadian or U.S. decision makers.

Response to Morrison-Maierle

171) A discussion of costs of salinity mitigation has been added to the economic impacts section. A discussion of saline seep has been added to the water quality section.

172) The statements on pages 106, 107, and 131 of the DEIS respecting irrigation water requirements should be revised and any reference to 18.7 inches per year diversion requirement should be deleted.

173) The comparison of diversion requirements is meaningless and has no merit in the EIS. No conclusions are affected by the number selected for diversion requirement, and the DEIS presents an issue strictly unrelated to the purposes of the EIS.

The determination of 18.7 inches per acres as a gross diversion requirement by Tetra Tech is clearly erroneous for the following reasons:

174) ° alfalfa consumes water and produces crop yields long before the first spring frost and long after the last spring frost. Accepted practice for determining the growing season of alfalfa provides for beginning growth when air temperatures average 55 degrees and ending with the last killing frost (28° Frost as distinguished from last frost-free day).

175) ° water is consumed and otherwise lost within the crop root zone during the non-growing season; a factor not considered by Tetra Tech.

176) ° measurement of consumptive use (San Juan Agricultural Experiment Station, New Mexico; Snake Conservation Research Center, Idaho; Roza Research Plots, Washington; among others) conclusively show that the Blaney Criddle equation with published crop coefficients (.85 seasonal coefficients) predicts as little as 60 percent of actual consumptive use. Moreover, crop yields are proportional to consumptive use.

177) ° May, a principal month of the growing season, was not considered by Tetra Tech.

178) ° Tetra Tech did not consider that only a percentage of total precipitation is effective in meeting crop water requirements.

Responses to Morrison-Maierle

172) Based on further investigation of the transpiration demands of crops grown in the Poplar River basin diversion requirements have been changed. The extent of these changes will be apparent in the following comments. These new calculations show that the diversion requirement of 18.7 inches is too low. Such references to this value have been changed.

173) The irrigation requirements determine the amount of water diverted from the Poplar River. It was necessary to compare various estimates to see if the values used in the model were correct. In addition, the amount of acreage which can be irrigated and therefore future economic impacts are directly dependent upon diversion requirements and thus are a vital part of the EIS.

174) The first sentence of this comment is not understandable. The USDA Irrigation Guide for Montana states that alfalfa consumes water between May 1 and September 29. As a result of comments we have defined the irrigation season as beginning May 1 and ending September 20.

175) Winter losses were assumed to be negligible compared to growing season losses. Because the soil freezes and the ground may be covered with snow, little migration of water out of or into the root zone is likely. Furthermore, the maintenance requirements of water for a dormant perennial are extremely low.

176) This is a valid point. However, the under prediction is not as low as 40 percent. The Blaney-Criddle method underpredicts by about 20 percent (i.e. predicts 80 percent of crop requirements on the average). This has been accounted for, and crop consumptive use estimates have been revised.

177) Pursuant to these recommendations and those of others, we have included May in the irrigation season.

178) Effective precipitation calculated according to Doorenbos and Pruitt (1977) is being used instead of total precipitation in all pertinent calculations. No correction is made for soil storage.

The data presented are so grossly inaccurate that a shadow is cast over the credibility of all technical determinations in the DEIS.

179) 5. If the DEIS at page 1 is intending to conclude that the Fort Peck Tribes are limited to irrigation of 4,186 acres rather than the full acreage entitlement of the Tribes, the statement is untrue and should be deleted. Any determinations by EPA or its agents that the capability of the land is less than proposed by the tribes will be met with strong objection.

The findings from EPA's operation studies of the Tribes' reservoirs and other supporting bases for making determinations limiting the Tribes' use will be required.

Response to Morrison-Maierle

179) The DEIS does not refer to capability to irrigate but to the number of acres that can be irrigated in the summer when four 300 MW units are operating, the recommended apportionment is in operation, the two reservoirs on the Fort Peck Indian Reservation are in operation, and there is a median flow with no consideration of carryover storage from the previous year. The full acreage of 20,618 acres was considered in the EIS. If carryover storage from wet years is available, then the acreage could be irrigated. In fact the inflow to the reservoir would be higher than predicted in the model because no structures presently exist on the Middle and West Forks to restrict the flow coming across the International Boundary to the apportionment allowance. The summary has been expanded to explain this.

COMMENTS ON THE
DRAFT ENVIRONMENTAL IMPACT STATEMENT
IMPACT OF CANADIAN POWER PLANT
DEVELOPMENT AND FLOW APPORTIONMENT
ON THE POPLAR RIVER BASIN
BY
ROBERT D. SCHNEEKLOTH

I want to thank you for the opportunity to present my concerns about the "Draft Environmental Impact Statement" on the Poplar River Basin and surrounding areas.

180) The concerns of various persons and organizations were very aptly presented at previously held hearings. Along with the concerns, major shortcomings of the International Poplar River Water Quality Board's final report were exposed and discussed, all in some detail. They are a matter of record at this time. I realize this involves a volume of material which may account for your apparent oversight of and non-use of this information in other preparation of the Poplar River Draft Environmental Impact Statement. I would, therefore, like to call your attention to some additional references of record that I feel deserve further and careful consideration.

International Joint Commission Hearing Transcripts:
Sept. 10, 1979 - Roades--pages 205-214'
Sept. 10, 1979 - Sims--pages 249-259
Sept. 11, 1979 - Schneekloth--pages 10-33
Oct. 16, 1979 - Schneekloth--testimony
Oct. 16, 1979 - Stoneberg, Ronald P.--testimony
Oct. 16, 1979 - Roades--Final comments.

I am unable to refer you to the page numbers of the October transcripts as they were not made available to us.

There were other items, which would probably have altered the context of the impact statement had they been given the consideration they deserved, such as:

181) 1. Molybdnosis and other possible problems of this type.

182) 2. Liver pyrosis of Northern Pike - which wasn't predicted but made its presence known after some $800,000 had been spent.

183) 3. Mercury contamination and lack of followup.

184) 4. High incidnece of respiratory disease - livestock and human and the added synergistic effects of smokestack emmissions, water pollution and weather extremes.

185) 5. The increase of lung cancer by some forty-eight percent in areas surrounding coal fired plants.

6. The glaring lack of input into the whole process by Range Management scientists.

Responses to Schneekloth

180) The Transcript of the September, 1979 public hearing was used to prepare the DEIS. The Transcript of the October, 1979 hearing was not available to EPA. However, EPA personnel were present and their notes were used to prepare the DEIS. Also, Rhodes written testimony and later response was available and used to prepare the DEIS.

181) Molybdnosis is a chronic cattle disease caused by imbalance of the copper-molybdenum ratio. Because the critical factor is the ratio and not a specific limit the IJC did not specify a criteria for molybdenum. High values of molybdenum were measured in a few wells in the Frenchman Formation in Saskatchewan. This formation is below the one which is being mined and where ash lagoon seepage would enter.

182) This statement cannot be addressed because the location and circumstances of this occurrence are not given.

183) See responses 102 and 249.

184) Health effects were addressed on p. 90 of the EIS. These statements here cannot be addressed directly due to lack of specific information on where they occurred and under what conditions.

185) Due to the nature of the project impacts, on rangeland will be minimal. Data were not available to make quantitative estimates. Agricultural personnel in the U.S. Department of Agriculture and Montana were consulted.

186) 7. Lack of input from trained and experienced Agricultural Finance people.

187) Many of the agricultural costs here figured with prices from the low end of the price cycle. No economic impacts were expressed using parity prices, target prices or prices from the top part of the price cycle.

In addition to the above mentioned references, I am enclosing copies of TCBA testimony presented at the September and October, 1979 hearings.

Sincerely,

Robert D. Schneekloth

Robert D. Schneekloth

Responses to Schneekloth

186) The personnel who conducted the economic analysis have experience in assessing agricultural impacts in Montana.

187) The figure used for additional income from irrigated agriculture was $50/acre. This is well above the $42.50/acre reported by Lufe (1979) and allows for generous price increases.

(1)

Good Evening; My name is David Johnson, I am here to convey the views and sentiment
of the Ft. Peck Tribes concerning the Draft EIS Tetra teck has done for the EPA.
First I personally would like to say that I am becoming disillusioned with the
Environmental Protection Agency. The report which EPA has contracted to a private
consulting firm from California and endorsed as a Environmental Impact Study seems to
be nothing more than a report, a light weight Literature review. This I am afraid,
188) is not why EPA was created nor is it closeto the quality of work which one would
expect to see coming from the Region VIII headquarters of EPA. Well, Besides that
point, I would like to now speak for the FT. Peck Tribal Council. The Ft. Peck
Tribes have stated their views and position concerning apportionment of the Poplar
River on record at three previous hearings here in Scobey in front of the International
Joint Commission. We have previously stated our position which I will repeat now,
and I quote " The Ft. Peck Tribes continue to assert their Full Rights to all the
Natural Flows of the Poplar River, undeminished in Quantity and Quality." This
position had been asserted consistantly since consideration of apportionment of the
Poplar River. There is No Change in the position of the Tribes. This position
189) is predicated upon Numerous U.S. Court decisions, primarily the Winters Doctrine,
Where the Supreme Court established the doctrine of Implied Reservation of Waters.
The Winters Reserved Waters Rights Doctrine provides that upon the establishment
of any Federal Indian Resevation the United States Reserves apportennant water then
unappropriated to the extent needed to accomplish the purpose of the Reservation.
This Winters Right Vests on the date of the Creation of the Reservation and is superior
to the rights of any Future appropriators.

Now we see that EPA has Ignored our claim and that such an ignorance has resulted
in an Impact statement which does not address the true potential Impacts of the
Candian Power Plant on the local environment and economy. You should not be unware
that the Ft. Peck Tribes are relying on furture agricultural development to improve
the poor economic conditions on the reservation and to bring Indian employment levels
up to match those [illegible] the surrounding region. Agricultural development on the

Responses to Johnson

188) The EIS included results of air and water quality modeling, detailed calculations of crop yields, comparative analyses of 32 different scenarios at three probability levels and 12 months of the year for 12 stations, and a detailed analysis of biological data. In addition, SPC and IJC reports were reviewed and used to determine where differences of opinion existed with regard to projected impacts.

189) A discussion of the Boundary Waters Treaty and the Winters' Doctrine has been added to Chapter 2.

Reservation is the primary stepping stone the Tribes have to become socially and economically self sufficent.

- The Poplar River is the largest of the Interior Reservation Streams, and over 126,000 acres of irrigable soils could be served from the river if adequate water supply were available. However the Natural Stream Flows of the Poplar River could supply only a small portion of the water required for so large an acerage. Several resevoir sites exist in the Basin that would store water during high flows and distribute it for irrigation during dry periods. With the construction of two resevoirs on the Poplar River, the Ft. Peck Tribes could Irrigate 15,000 to 20,000 acres. We have determined that crop reciepts would exceed construction Costs. We have also determined that the Impact of the Poplar River apportionment proposed would reduce annual crop receipts by an estimated $675,000 even with both storage resevoirs in operation. It is important to recognize that other benefits would be reduced also for the Tribes.

190) - The Ft. Peck Tribes feel that since the Poplar River is the largest of the reservations interior streams and has the most development potential, and that all possible consideration be given the full development of the resource as a step in the improvement of the reservation economic conditions and toward tribal self sufficiency. Now, we feel the Evironmental Protection Agency is Irresponsible in issuing an Impact Study which draws some very strong conclusions with out qualifying nor providing any sort of justification for those conclusions. A very good example of this is on pages 1 and 2 of the main Impact statement.

191) - Here EPA has concluded that only 4,186 acres of land can be irrigated out of the Poplar River near Poplar. That is basically all they say about that, and in very strong language, with out justification for their statement. The Ft. Peck Tribes have spent hundreds of thousands of dollars to study the potential and feaseability of Irrigating out of the Poplar River. As I have previously mentioned, We have concluded, with the help of many experts that we in fact can Irrigate 15,000 to 20,000 acres from the Poplar River. Now the Environmental Protection Agency is trying to tell us that there are only 4,186 acres thich could be irrigated from the Poplar

Responses to Johnson

190) An expanded summary has been prepared for the final EIS which includes the major reasons for the conclusions and any qualifications.

191) See response 179.

River. They are making this statement with out any sort of technical justification. The Ft. Peck Tribes will not tolerate this statement and Insist that it be removed from the Report.

We are especially sure that tetra-teck the so called environmental specialists have not conducted nor are capable of conducting the engineering studies necessary to determine the irrigation potential of the Poplar River Basin.

192) —It is this sort of arbitrairy and caprecious statements which EPA had endorsed that makes the Ft. Peck Tribes weary of their capability and position concerning the Protection of human health and the Environment. As I have mentioned, the proposed apportionment of the Poplar River would result in an estimated annual loss of $675,000. to the tribes. Tetra teck and EPA have not assessed the economic and social impacts of this proposed apportionment as it relates to the Ft. Peck Tribes. You have merely discounted the fact that we do have a very good Irrigation development potential in the Poplar River.

193) Furthermore you have indicated in your report that the proposed Federal Class I Air Standard for SO2 on the reservation will be exceeded by two power plants, Without any controls.

The report projects excendence of the standard but does not indicate weather it is the 3 hour or 24 hour standard which is being exceeded, nor how many times it will be exceeded. The report also predicts no detectable

194) impacts on plant species from SO2. This is contrary to the predictions of Gelhouse, et.al., in the State of Montana's Scientific and Engineering Advisory Panel on the Poplar River Air Quality Issue Paper. Where predictions indicate a minimum loss to agricultural productivity with in a 40 km radius of 2% the power plant, resulting in a dollar loss of at least $177,408 annually in Daniels County alone.

Responses to Johnson

192) The EPA is aware of the need for agricultural development to improve economic conditions on the Ft. Peck Reservation. It was assumed that irrigation systems would be installed only on that acreage irrigable with mean flows for June. The natural variation in rainfall will not allow 20,000 acres to be irrigated every year even with both reservoirs. Therefore, the estimates presented tend to overstate possible impacts, because it is unlikely that all 20,000 acres would be fully developed with irrigation systems.

193) As shown in Table 3.1-2, the modeling results indicated that the operation of two units with zero percent SO_2 control would result in the contravention of the 24-hour maximum PSD standard at the proposed Class I site at the Fort Peck Indian Reservation. The maximum 3-hour concentration for the same plant operating characteristics is equal to the maximum allowable level. The predicted frequency of violation of the 24-hour maximum SO_2 concentration is low. For example, the second highest predicted 24-hour SO_2 concentration along the same azimuth on which the violation was predicted, is below the allowable standard. The results of the same model using meteorological data collected over a three-year period at Scobey, Montana (Gelhaus, 1980) indicate a violation of both the 3-hour and 24-hour maximum allowable SO_2 concentrations at the proposed Class I area with the operation of a single 300 MW unit. Estimates of the frequency of violations of these standards were not provided by Gelhaus (1980).

194) As indicated in the response to the comments of Mr. Gunderson, no supporting evidence for the 1 to 2 percent loss in crop yield predicted by the State of Montana's Scientific and Engineering Advisory Panel was presented. The relationship between sulfur accumulation in soils and loss in plant yield has not been demonstrated.

Your report has not thouroughly investigated this prediction and again has made another arbitrary statement, and I quote " Comparison of predicted concentrations of SO2, NOx and particulates with acute and chronic threshold limits for selected plant species Indicate no detectable Impacts on the tevestrial vegetation" unquote.

195) The Ft. Peck Tribes demand that the EPA undertake the necessary studies to determine the Impact of the proposed Poplar River Power Plant on the environment, the social welfare and the economy of the Ft. Peck Indian Reservation and its residents. We feel that the intentional disregard of the tribes prior and paramount rights to the use of the water of the Poplar River and the omission of the Tribes previously stated and published plans for the use of the river consititules sore neglegence of the Federal Feduciary and trust responsibility of the Environmental Protection Agency.

Response to Johnson

195) This EIS represents the findings of an extensive investigation into the environmental and economic consequences of the proposed Poplar River apportionment. Discussion of the impacts of the various apportionment scenarios on the Ft. Peck Indian Reservation is an important part of the EIS. We have tried to fully respect all Indian rights in this analysis.

msu

DEPARTMENT OF PLANT & SOIL SCIENCE

COLLEGE OF AGRICULTURE
MONTANA STATE UNIVERSITY, BOZEMAN 59717

October 8, 1980

Mr. Gene Taylor
Environmental Protection Agency
Federal Building, Drawer 10096
301 South Park
Helena, MT 59601

Dear Mr. Taylor:

This letter contains my additional written comment on the EPA draft EIS, "Impact of Canadian Power Plant Development and Flow Apportionment on the Poplar River Basin", EPA 908/5-80-003 dated July 1980. Further to my oral comment presented at the public hearing in Scobey, MT on Sept. 23, 1980 (copy attached), the EPA is requested to utilize the following comments in revising the draft EIS and in their future contracting activities.

Although it does contain some useful material, this draft EIS is organized and written so poorly that it precludes the intended objective of protecting the U.S. citizens and their interests in the Poplar River Basin. In addition, the draft EIS is lacking technically, especially in the areas of soil chemistry, crop physiology, agronomy and irrigation agriculture in general. It is my contention that this is the result of the failure of EPA or their contractor, Tetra Tech Inc., to engage the services of certified professional soil scientists, crop physiologists, and agronomists to assist with the agronomic and irrigation aspects of this study. It is recommended that all future EPA activities of this nature, at any location, include the use of such certified professionals. The cooperation of the American Registry of Certified Professionals in Agronomy, Crops and Soils (ARPACS) can be readily obtained by contacting their Executive Director, Dr. Martin Openshaw, ARPACS, 677 South Segoe Road, Madison, WI 53711.

196) The comment which I made about irrevelent material in reference to the expenditures of $269,000 in the U.S. by Canadian workers (see item 1 in my oral comment, attached), as explained at the hearing by an EPA representative, may not actually be irrelevant; however, it is presented in an improper perspective. Inasmuch as Daniels County is a sub-unit in the economics of the state of Montana, which in turn is a sub-unit of U.S. economics, the cost of the IJC Poplar River Water Quality Study and the cost of this EIS must be mentioned in the same paragraph to put the peripheral economic factors into proper perspective. My point is validated by the fact that EPA chose to mention on page 56 that SPC spent $50 million on parts and machinery which did not derive benefits in Daniels and Roosevelt Counties or elsewhere in Montana.

197) On page 2 and elsewhere in the draft EIS, EPA makes the misleading statement that operation of a single 300 MWe unit will not lead to significant degradation of water quality for irrigation. The predictive data on boron and TDS levels in the water and predicted decreases in irrigated

Responses to Sims

196) We did not intend to overstate the impact of the money spent on the U.S. by Canadian workers but offer it only as one fact among many.

197) The statement on page 2 referred to water quality in the river. The addition of one 300 MW unit does not change the quality significantly relative to the quality after construction of the reservoir (see response 206). Impacts on individual farmers have been added to the EIS.

crop yields do not support this generalized conclusion. It seems to me that one of the problems which the preparers of the draft EIS had in interpreting their data is related to computing damages due to yield reductions of irrigated crops which impacts primarily on the irrigation farmers, but is presented on a prorated basis as impacting on all the farmers of the Basin including dryland farming and range grazing operations. Presenting the impacts in this manner would be acceptable if, and only if, in the same paragraphs in summary and elsewhere in the report the topic is addressed, that the impact on the individual irrigation farmer is specified, e.g., irrigated crop yields will be reduced by 30%, 40%, or 50% annually and possibly irrigated agriculture will be precluded entirely. This constitutes a significant impact on each and every individual irrigation farmer in the Basin and must be stated as such even though these losses can be made to appear insignificant when diluted within the impacts of the total farming community in the Basin.

198) Also, to make the empirical functions to predict yield reductions of irrigated due to increasing levels of boron, TDS and SAR more acceptable and to emphatically indicate their limitations, they should be qualified by stating in the summary, and every other place in the report where they are discussed, e.g., page 135, page 141, that they were applied to compute yield reductions of irrigated crops by considering the effects of boron, TDS and SAR to be additive when, in fact, it has been reported in numerous scientific journal articles that in many cases when multiple stresses are applied to plants, the effects are often compounding rather than additive. In a more simple statement, a plant suffering from boron toxicity is in poor condition and contend with the effects of excessive TDS. Thus, since it was not possible for the preparers to include the very complex and compounding interactions of the multiple stresses of boron, TDS, specific ion toxicities, SAR, etc., in computing predicted yield reductions, these predictions should be accompanied by a qualifying statement. I suggest something like the following: "These predicted reductions in crop yields approximate the minimum damage that can be expected. The compounded, negative effects of the multiple stresses applied to plants by excessive levels of boron, TDS and SAR are likely to result in significantly greater yield reductions. The limited resources provided for this study precluded the prediction of actual yield reductions which would result from the complex interactions of these multiple stresses."

199) Relative to item 8 in my oral comment, the draft EIS should be modified to convey the proven phenomenon of a soil and boron-containing irrigation water reaching an equilibrium involving a point of maximum adsorption of boron by the soil at some point in time; and furthermore, at that point in time, the system is known to acquire the boron concentration of the irrigation water as the minimum boron concentration of the soil solution. If the boron concentration is increased such as by operating the power plant, the soil will adsorb more boron and new, higher concentration of boron in the soil solution will develop. Also, it has been shown that about 1 or 2 orders of magnitude more water is required

Responses to Sims

198) The effects of the three individual parameters, boron, TDS, and SAR, were not considered to be additive. Rather the interactive effect was considered of TDS and SAR (effect a) and boron (effect b) separately. Effects a and b were then considered to be additive. As stated in responses to comments of Cameron, no quantitative data were found describing the interactive effects of boron and other substances on crop response.

199) This paragraph discusses the phenomenon of boron by stating that at some point in time the boron adsorption will reach a maximum. At that point the boron concentration in the soil solution will be equal to the boron concentration of the irrigation water.

Theoretically, this maximum value cannot be reached. However, by using Langmuir's theory it can be approximated. We have estimated Langmuir K and Q to be on the order of 50 and 0.02 for Poplar River soils. Assuming 99 percent saturation of the exchange sites for boron the equilibrium concentration required would be 1990 mg-B/l. A solution concentration of 200 mg-B/l would be required to saturate half of the sites. Concentrations of this magnitude and hence, saturation of all boron adsorption sites are unrealistic. It is true, however, that higher irrigation water values will result in higher boron soil solution concentrations. This is accounted for by our boron mass balance approach.

to reclaim a boron polluted soil than was used to make it. The expense of this type of reclamation should be mentioned in the EIS. That is, it will take 10, 20 or more times the number of irrigations to reclaim the soil and the development of the boron polluted soil could be over a period of a few to several years.

200) The irrigation requirements of alfalfa calculated by the preparers on page 107, based on the Blaney-Criddle equation and the invalid assumption that no irrigation is required in May and the latter part of September, must be replaced by a more rational derivation. The irrigation requirements of alfalfa and other crops irrigated in the Basin should be based on a tried and proven system, if one exists. I maintain that such a tried and proven system exists. Specifically, the U.S.D.A. Soil Conservation Service 1974 publication entitled "Irrigation Guide for Montana" has been developed, in part, through actual practice through the service activity of SCS in designing irrigation systems for Montana farmers over the past few decades. Since SCS has a record of successfully designing irrigation systems for Montana farmers using their guide as a basis, it should be viewed as a better basis for determining irrigation requirements. Also, since alfalfa is a perennial crop, irrigation in late September and/or during October is necessary to fill the soil profile with water to keep the alfalfa alive over winter. The Blaney-Criddle system used in the draft EIS does not account for this over-winter need for water by alfalfa.

201) Further to the fact that alfalfa is a perennial crop, the manner in which the draft EIS is written suggests that the conclusions in the summary, which states that no significant damage is predicted, were based on average years. These parts of the draft EIS should be rewritten to incorporate the fact that some of the greatest hazards from having to irrigate with low quality water comes in years with below-average precipitation, such as was experienced by the Scobey area in 1979 and again in 1980. One of the primary effects of high salinity irrigation water on alfalfa is stand reduction. Stand reduction is a form of damage which must be integrated over several years succeeding the year of damage. If the salinity level becomes high enough or is maintained for successive seasons complete failure of the crop results. This type of response to increasing salinity of the Popular River must be included in the EIS.

It is presumptious of the preparers who, at best, have extremely limited experience in irrigated farming and minimal training in the agronomic sciences, to recommend irrigation farming practices for Poplar River Basin irrigators, many of which are using irrigation systems designed by experienced U.S.D.A. Soil Conservation Service irrigation specialists (see pages 146-150). Also, the suggestion of how on-farm management practices which involve further investment, pages 146-150, as mitigative measures must be accompanied by inclusion of the costs for such practices in the economic damage evaluations along with the other factors which I mentioned in item 14 of my oral comment.

Responses to Sims

200) This paragraph suggests that the Blaney-Criddle method for computing consumptive use of alfalfa be discarded for the method contained in the "Irrigation Guide for Montana", (USDA-SCS, 1974). This publication itself uses the Blaney-Criddle formulation to estimate consumptive use. The irrigation requirement for May has been included.

201) These costs have been incorporated into the estimates.

202) The discussions and conclusions regarding the effects of SO_2 deposition on soils in the Poplar River Basin on pages 167 to 175 are not entirely correct. On page 174, the middle paragraph concludes that there will be no problems with acidification of the soil on the basis that these soils are all highly buffered by $CaCO_3$. This conclusion is not correct. Although some of the soils in the Basin are buffered by $CaCO_3$, many are not. The use of the alternate crop-fallow management system on the upland soils of the Basin has had the same leaching effect as would be found in zones of higher rainfall. After several years, the net effect has been to leach the soils to the extent that many soils have lost the $CaCO_3$ in their Ap horizons, some of which have actually developed acidic Ap horizons. Increased SO_2 could hasten the development of acidic conditions. A common observation of similarly leached soils elsewhere in Montana is the development of surface crusts which impede crop emergence and root penetration. A soil pH of 8.0 or above is an indication of the presence of $CaCO_3$, lower pH value indicates its absence. Out of 212 Ap horizons in Daniels County tested by the MSU Soil Testing Lab, 22% had a pH above 8, 57% had a pH between 7 and 8 and 21% had a pH below 7, with some as low as 6.0. Increased SO_2 emissions would constitute a damage to these soils.

203) In closing, I sincerely hope that these comments and suggestions will help EPA and Tetra Tech Inc. to revise this draft EIS into a more useful document. My harsh criticism of the draft EIS at the public hearing in Scobey was justified by the poor manner in which it was written and its technical deficiencies. Although they had to deal with some extremely complex environmental interactions, the preparers did not express the limitations of their evaluations and suggest that the actual damaging effects of further degradation of the Poplar River water could be much greater than indicated in the draft EIS. The data generated by the preparers of this draft EIS and the manner in which it is presented lead me to believe that if the U.S. Government utilizes the conclusions in the EIS to enter into an agreement with Canada, all irrigation farming in the Poplar River Basin will be precluded. The draft EIS must be restructured and rewritten to emphasize the severe impacts on irrigation farming.

Respectfully,

James R. Sims
Professor of Soil Science

JRS/lmc

Responses to Sims

202) Soil pH is not the best indicator of the capacity of a soil to buffer strong acid. Alkalinity is the best direct measure. The carbonate ion(CO_3^{2-}) is a component of alkalinity but in the pH range from 6 to 10 the bicarbonate ion (HCO_3^-) controls the buffering capacity (Stumm and Morgan 1981). Therefore, the presence of calcium carbonate is not a necessary condition for soil buffering ability. Use of only one component of alkalinity (CO_3^{2-}) (i.e. 4% Ca CO_3) indicated no pH change when soil was exposed to acid deposition (Smetana, 1979)

203) We have attempted to correct the deficiencies in the draft EIS and to present it in a more concise and readable manner via this final EIS. The purpose of a draft EIS is to foster review and critique of its preliminary conclusions and all comments are accepted in this context. The impacts on irrigation have been stressed. It should be realized that the severe impacts predicted are after operation of four 300 MW units. SPC does not presently plan to build more than two 300 MW units.

Statement of Dr. James R. Sims, C.P.S.S., C.P .Ag, Research Soil Scientist, Montana Agricultural Experiment Station, Bozeman, regarding the draft environmental impact statement (EPA 908/5-80-003), "Impact of Canadian Power Plant Development and Flow Apportionment on the Poplar River Basin", presented at the public hearing held in Scobey, Montana on Tuesday, September 23, 1980.

Upon initial examination of the draft environmental statement, "Impact of Canadian Power Plant Development and Flow Apportionment on the Poplar River Basin" (EPA 908/5-80-003), I found a number of deeply disturbing features, statements, and predictions. Some of these disturbing aspects of the draft EIS are outlined below:

204) 1. Irrevelant material should be removed. For example, on page 2 and again on page 4, EPA points out $269,000 expenditures in the U.S. by Canadian workers plus some secondary benefits yet fails to mention the U.S. share of approximately $750,000 spent by taxpayers to finance the "International Poplar River Water Quality Study", conducted by the IJC and fails to mention the taxpayer expense for this EIS which is estimated to be $175,000, all of which results in a net loss to the U.S. taxpayers of a few hundred thousand dollars.

2. Based on the list of preparers, this draft EIS was prepared without the benefit of a professional soil scientist, crop physiologist, or agronomist on the staff.

205) 3. The EPA, on pages 17-18 and elsewhere in this draft EIS, with various scenarios, predicts B concentrations from 0.8 to 5.5 mg/l with most of the predictions around 2.0 mg/l. EPA and U.S. Geological Survey personnel, working with their Canadian team members, predicted B concentrations from 5.4 to 11.5 mg/l with most of the predictions around 8.0 mg/l or above. This extreme variance in predicted B concentrations is not acceptable and must be resolved. Differences of a few percent would be understandable, but differences of 300% are not!

206) 4. The EPA, on page 2 and elsewhere in this draft EIS, states that operation of ~~two~~ single 300 MWe units will not lead to significant degradation of water quality for irrigation; and yet, on page 131 it presents regression equations which indicate that increasing the B level by even 1 mg/l will result in yield reductions from 2.1% to 8.7% for the various crops, and on page 140 present yield reductions of 39% to 75% (10% leaching fraction) and 7% to 25% (30% leaching fraction) due to salinity and/or sodicity for the various crops. The EPA needs to examine the meaning of the word "significant".

207) 5. The irrigation requirements of alfalfa which were calculated by EPA on page 107 were based on the assumption that no irrigation is required during the month of May. That assumption is not valid. The EPA calculated net requirement of 11.8 inches and, with a conveyance efficiency of 63%, a gross diversion requirement of 18.7 inches per acre. This is, as EPA says, roughly half of the irrigation requirement calculated by Morrison-Maierle for the Fort Peck Reserva-

Responses to Sims

204) See response 196.

205) Boron concentrations for scenarios 23 through 27 did not include ash lagoon seepage. The maximum concentration predicted with no seepage and 4 300 MW units is 8 mg/l (Table G-2.1). The maximum concentration predicted with the ash lagoon seepage (scenario 8A) and 2 units is 20 mg/l. Differences are due to assumption used to develop scenarios. The EIS analyzes both worst case and conditions expected based on SPC's present plans.

206) The change in concentration of the modeled constituents from scenario 3 (Cookson Reservoir) to scenario 28 (Cookson Reservoir and 1 unit operating) is small as shown by examing Tables G-2.1 through G-2.16. The decreases in crop yields were computed from the present yield using average soil properties and not from the yield using Poplar River water for irrigation. The large yield decreases are due to the lack of dilution and larger applications in low rainfall years.

207) The discussion of diversion requirement has been deleted from the main text. The month of May has been included in calculation of crop consumptive use.

tion. If EPA would have consulted the U.S.D.A. Soil Conservation Service 1974 publication entitled "Irrigation Guide for Montana", they would have found that irrigated alfalfa in this area has an average consumptive use, in May, of 3.70 inches, an average effective rainfall of 1.32 inches, and thus, an average net irrigation requirement of 2.33 inches.

Furthermore, the USDA-SCS guide lists the total consumptive use of water by alfalfa in this area as 25.98 inches from May 1 to Sept. 29, the effective rainfall as 6.63 inches, which leaves a net irrigation requirement of 19.35 inches. With a conveyance efficiency of 63%, this gives a gross diversion requirement of 30.7 inches, which is much closer to the Morrison-Maierle requirement. Also, EPA did not include the water required for effecting a 0.3 leaching fraction.

208) 6. Furthermore, on page 107, EPA used the precipitation probabilities for Havre, Montana, which is about 220 miles to the west. There are published precipitation probability data for weather stations in Northeastern Montana. Also, according to my collegue, Dr. Joseph Caprio, Agricultural Climatologist and Meteorologist for the Montana Agricultural Experiment Station, such probability data could have been easily computed for Scobey by supplying the computer with about 50 bits of data from the local weather station. With so much hard data from the immediate area available, it is difficult to justify using weather data from a station 220 miles away.

209) 7. Conclusions in the summary that no significant damage was predicted were apparently based on the "average years"; EPA needs to be reminded that the greatest hazard from having to irrigate with low quality irrigation water comes in years with below average precipitation. As I told the U.S.-Canada IJC last fall, 1979 precipitation was considerably below average, 1980 has turned out even worse - we have hardly received an inch during the growing season this year. The statement by EPA on page 108 that their design quantity for alfalfa is realistic ignores the fact that dry years occur and that half the time precipitation will be below average.

210) 8. In reporting the impacts of boron on crops and the soil chemistry of boron, EPA cites the work of Hatcher and others, and states that when waters containing boron are applied to soils, some of the boron is adsorbed. Furthermore, EPA uses this as justification to assume that Scobey area irrigated soils can remove sufficient excess boron from the contaminated irrigation water to prevent crop damage. This is not the final end point in the reactions between boron-containing irrigation waters and soils. Hatcher, et al., went on to apply the Thomas-Hiester-Vermeulen equations showing that the volume of water containing boron required to reach equilibrium with the soil decreases as its boron concentration increases, and that the elution of boron from saturated soils always requires a larger volume of water than that required to effect saturation. In lay terms, this means the higher the Boron content of the water, the quicker the soil becomes

Responses to Sims

208) The Scobey precipitation data were not used when irrigation requirements were originally calculated. Subsequently, Scobey temperature and precipitation data have been used in our crop consumptive use estimates. We note that the precipitation probabilities obtained originally from Havre and adjusted for Scobey coincide with those obtained from the Scobey data.

209) Precipitation probability was taken into account using dilution factors (see Appendix G) to simulate soil water quality degradation in below- and above- average years. The design diversion quantity was based on rainfall of a 1 in 10 year drought.

210) We agree with your statement on the conclusions of the work of Hatcher, and Bower (1958). Even though their conclusion was that desorption required greater volumes than adsorption, they also concluded that either of these processes was adequately described by Langmuir theory in the concentration range of Poplar River waters. Rhoades, _et al._ (1974)concluded that Langmuir theory did not describe the desorption of native boron. In both studies soils with native boron were used although Hatcher and Bower used soil with low initial boron whereas Rhoades _et al._ used soils with widely varying initial boron. The boron added in irrigation water will be associated with the fast reaction referred to by Griffin and Buran (1974) and therefore subject to rapid desorption. Thus our approach is valid since we consider only boron held by adsorption and not native boron. Leaching of native boron is not an issue associated with power plant development.

saturated with boron, and at that point, the soil solution has the same B content as the irrigation water. It also means that it takes several times more water to reclaim a boron-polluted soil than it did to make it.

Thus, EPA's contention that the soils in the Poplar River Basin can permanently act as a scrubber to remove B from the irrigation water is invalid.

211) 9. The statement on page 2 that the impoundment of water in Cookson Reservoir has resulted in improved water quality on the East Fork at the international border in all seasons except spring, is not a statement of fact, but rather is an assumption. It is an assumption based on another assumption that one year's data, 1975, represent the long term average.

An equally valid assumption is that the present water quality of the East Fork at the international border reflects the true average water quality on the East Fork for the period of impoundment (1975-1930), and that these TDS and boron levels would be a more valid base from which to judge future degradation than are the 1975 data. The actual operation of the 300 MWe unit will lower the quality of the water in the East Fork. This is consistent with EPA's statement on page 126 that the outflow quality from the reservoir is determined by complete mixing of the reservoir and mass balance of all reservoir inflows and outflows.

212) 10. Also, on page 126, EPA states that the quality of surface irrigation return flow was calculated at 10% higher than the quality of the diverted water. The quality of the return flow will be much lower than that of the diverted irrigation water. Grossly invalid statements such as the one by EPA above cast doubt on the validity of the report.

213) 11. If there is any validity to any of the predictions in this report, the predicted yield reductions on pages 132, 140 and 141, which are substantial, would be very significant and is in serious conflict with EPA's statement on page 2, which says that operation or a single MWe unit will not lead to significant degradation of water quality for irrigation and other purposes.

214) 12. Manufacturing the yield reduction estimate as a function of SAR and EC as a logrithmic function of SAR and EC, and applying it without verification by experiment is scientifically unacceptable. I don't believe that the Scobey area irrigators should be asked to become your experiment to test this empirical function. Also, by the statement on page 135, this empirical function is supposed to have caused barley, wheat and oats to have experienced ion "starvation". If experiments were conducted and published, why are they not cited? Also, ion "starvation" should be defined.

Responses to Sims

211) The improvement in water quality due to the reservoir is shown by comparing model results for the historical case (scenario 2) to the Cookson Reservoir case (scenario 3) in Tables G-2.2 through G-2.13. The model is run using natural flows from 1933 through 1974 with water uses at a specified level of development subtracted (in this case historical uses or 1975 uses). The improved water quality can also be shown by comparing 1975-1977 data collected by the U.S. Geological Survey and Montana State Water Quality Bureau as follows:

	TDS	SO_4	Boron	N_a
1975	1010	321	3.15	241
1976	832	242	-	182
1977	915	263	1.93	204

Note: Values given are mean values in mg/l at East Fork of Poplar River at the International Boundary.

Statistical analyses of 1976 and 1977 at the station on the East Fork at the International Boundary have been added to Table A-5.1.

212) This error has been corrected. Substitute "concentration" for "quality" as intended originally.

213) See response 212.

214) This function is based on existing data which appears in the literature and has been cited in the references. The comment regarding "ion starvation" is superfluous and has been deleted.

215) 13. On page 141, EPA states that they considered the effects of boron, salinity and sodicity to be additive. The report doesn't cite any reference as a basis for making this assumption. In many cases, when multiple stresses are applied to plants, the effects are often compounding rather than additive. This area of the report needs to be more thoroughly done. Boron has a toxicity effect; SAR has indirect effects on soil physical properties, aeration, reduced availability of calcium, phosphorus and other plant essential elements; and salinity has osmitic effects on water uptake and sometimes specific ion effects including toxicities and interference with the uptake of plant essential elements by plants. Such complex soil-plant-water relationships and interactions should not be treated so lightly and simply glossed over with unproven, empirical treatments such as EPA has done in this report.

216) 14. Nowhere in this draft EIS is there an indication that EPA considered the extra expense to Scobey area irrigators that would be required to effect leaching of the high salt levels that will develop in their soils. Also, no consideration was given to the expense for additional fertilizer to replace the plant nutrients which would be leached out along with the harmful salts. There was no mention of other increased production costs to the irrigators to use the high TDS, high boron water and the new on-farm management practices proposed.

Concluding Remarks

This draft EIS contains an excess of irrevelant material. It contains a great number of contradictions within itself. It utilizes a large number of invalid assumptions. It relies heavily on untested empirical solutions. It and the Poplar River Water Quality Report have such wide discrepancies in their predictions concerning irrigation water quality and the effects of high TDS and boron on crops that the effect of the Draft EIS simply further clouds the issues rather than to help clear them up. Even though it would be an additional cost to the taxpayer, I call for it to be redone. This concludes my testimony.

Responses to Sims

215) **This issue has been treated in response to the comments of Cameron.**

216) See response 201.

making this request.

I have some questions I would like to direct to the people that filed this, if I may, and I may have to refer to someone back in the audience if that's permissible.

HEARING OFFICER McCLAVE: And could the--we don't have a P. A. system, so the people in the audience--if you can identify yourself for the court reporter then we would be sure to get your name in the record.

MR. NATHE: There seems to be some discrepancy with regards to water quality or quantity in the apportionment. That's the first item I would like to--I would like to address. If you look at the water apportionment report, the first one, the yellow one, you don't have one up here, the IJC's water apportionment report, it seems like you people took that information and that information was based on one plant, and you have included two--two and up to four in the--there seems to be some conflict there.

I mean can I direct anything? Can I get a response back from the board on that?

HEARING OFFICER McCLAVE: Yes.

MR. NATHE: It seems like your--the four areas that
you look at vary from eight to twenty-one percent that we will
217) get on the east fork of the Poplar and then you have plugged
in more power plants, and this first recommended apportionment
only was on one power plant, and you don't have anything
regarding spills.

Response to Mr. Nathe

217) Modeling and impact analysis have been done for up to four power plant units. The additional evaporation and inflows to Cookson Reservoir were added to the model. Spring runoff is included when the reservoir was full. This occurred at the 1 in 10 year high flow cases on the East Fork. A comparison of the natural spill rate and spill rate under flo

side of the border, have went through four years of testimony in trying to stay up with the experts, actually from both sides of the line. We are not scientists. All we are primarily concerned about is protecting our environment and our overall I would say economic well-being, and I feel free to make the comment I don't care whether Saskatchewan Power puts in twenty power plants up there just as long as they don't harm us on this side of the border. That's been our primary drive down here is making sure that we are not harmed.

My question is is there anyone here that is from the
EPA? What happened to--in the Draft EIS to the infrared
photos that had been taken over this area since 1971? I can
218) remember sitting in 1977 with Alba (sic) Fond (sic) of the
EPA and Lieutenant Governor Ted Schwinden and myself, State
Representative Art Lund, State Senator Smith, in a conference
room in Helena when a decision was made to use those infrared
photos as a baseline data to make for sure that in the future
we were not being harmed, and I have never seen any of that
information come out anyplace.

Those were supposed to be reinterpreted at Las Vegas and in Wheeling, West Virginia, I believe, and what has happened to that information? That never shows up, because those infrared photos would give us a base line for those years prior to the establishment of that plant as to the the kind of information that we want for our own economic protection in the future.

Response to Mr. Nathe

218) The infrared surveys were used by Tetra Tech as explained at the hearing (see Figures 4.3-1 and 4.3-2 of the EIS). The original photos have been returned to EPA and will be deposited in a place accessible to the public in Scobey.

Secondly, on this air quality thing, is going through it I see where you make reference to the study done out in Corvallis, Oregon. Now, that study was--I don't know how I get ahold--I must apologize to you because I haven't really spent that much time myself on this thing, but it's my understanding that on those plant species which again I was involved with with Dr. Alba (sic) Fond (sic), who is no

219) longer with the EPA, and also Dr. Francis Sitoway (sic) from the USDA, Northern Agricultural or the Northern Plains Research Center at Sidney, Montana, Ed Weiss (sic), when the EPA wanted information as to the varieties that should be subjected to the effects of SO_2 and I guess nitrous oxides and stuff and that I see some of those plant varieties were tested out at Corvallis, but it's my understanding that there was a lot of question on the validity of those tests. They were not done especially with wheat for some reason during the--I don't know if it was the blossom stage or the heading stage, when wheat is supposedly the most susceptible, and I see that that data in turn is poured in here as substantiating the conclusions that are coming to or that you have come to with regards to air quality.

HEARING OFFICER McCLAVE: Are you talking about the study that was done around Colstrip? Corvallis also did--

Response to Mr. Nathe

219) The varieties of crops tested from planting through harvest in field experiments at EPA Corvallis included spring wheat, durum wheat, barley, crested wheatgrass, and alfalfa. In addition native grasses studied from seedling stage through harvest included western wheatgrass, Russian wild ryegrass, blue gramma grass, and needle and thread grass (Wilhour et al. 1977). Plant health including foliar damage and crop yield were examined during these studies. Results from other studies on the effects of SO_2 and NO_x are outlined in Table 5.6-1 of the EIS. These results were used in addition to the EPA studies in Corvallis.

Again, my name is Hal Robbins. I am the Chief of the Air Quality Bureau in Helena for the State of Montana.

I just have a couple of short things I want to say. One, we will be submitting written testimony to EPA for our final comments. Our comments will be incorporated in the Final EIS.

As was already mentioned, the Air Quality Bureau is playing a major role in the analysis of the air quality impacts. Our chief concern among many other things concerning the Draft EIS was essentially the use of the meteorological data in that air pollution model. The meteorological data in any air pollution model is extremely critical to the output of that model and it's extremely critical to the accuracy of that model.

The Air Quality Bureau since approximately 1977 had been conducting extensive meteorological monitoring and air monitoring in the Scobey area and will continue to do so. The Air Quality Bureau, therefore, is taking the exact same model that Tetra Tech ran and we believe to be a reasonable model, and we are inserting our data that we spent such long, hard hours on into that model.

That model, by the way, has been run. We now have
220) the data for that. Unfortunately, it just came out about two
days ago. We have not had a chance yet to analyze the dif-
ference between Tetra Tech's results and ours, but those

Response to Mr. Robbins

220) The results of the air quality modeling by the State of Montana have been incorporated into the final EIS. Their report is included in Appendix I.

220) Air Quality Modeling
Cont.

The Montana Air Quality Bureau performed additional air quality modeling (Gelhaus, 1980) using the CRSTER model and meterological data collected at Scobey for the period November 1, 1978 through October 31, 1979. This model was also used for the air quality modeling in the EIS using Glasgow data since the Scobey data were not available at the time of the DEIS preparation. Emissions data and stack parameters used in two modeling studies are compared in Table 1. The emission rates used are identical. Some of the stack parameters differ but not by a significant amount.

Table 2 compares the predicted maximum concentrations in the U.S. of the two modeling studies for a 600 and 1200 MW power plant. The predicted values for NO_x and particulates in the two studies are closer than the predicted values for SO_2. Detailed tables showing concentration at a given distance and direction are included in the Gelhaus report only for 1 hour maximum SO_2 concentrations. The performance of the model cannot be evaluated fully because tables showing predicted values on a given day were not included. However, the table (reproduced here as Table 3) for the 1-hour SO_2 concentrations does not show consistent results. For example, the occurence of single high values along a particular azimuth is not consistent with the Gaussian dispersion formulation which uses horizontal and vertical dispersion parameters to determine the spread of the plume and adjusts the dispersion-versus-distance curves based on the stability class (Budiansky, 1980). A concentration of 216 $\mu g/m^3$ appears to be a more realistic estimate of the maximum concentration based on the direction and other predicted values. This would be very close to the maximum concentration predicted by the EIS of 214 $\mu g/m^3$. Table 2 shows that even the maximum predicted values do not exceed the federal or Montana ambient air quality standards. The PSD Class II standards are exceeded only for the maximum 24 hour standard and then by 1 $\mu g/m^3$ for a 1200 MW plant but not for other cases.

The CRSTER model predictions were also used to determine whether violations of the PSD Class I standards could occur at the Medicine Lake Wildlife Refuge located about 105 km (65 miles) southeast of the plant and at the Fort Peck Indian Reservation boundary located 48 km (30 miles) directly south of the power plant at its closest point. The predictive capability of the CRSTER model falls off very rapidly at distances over 48 km (30 miles) but it can be used to provide an upper limit concentration. The predictions at these distances would be very conservative due to the use of average wind speeds and directions which are not a function of distance, the lack of vertical variation of dispersion coefficients, and the lack of loss with distance due to chemical processes and deposition.

The maximum 24-hour SO_2 concentration for a 1200 MW plant with no SO_2 control at the wildlife refuge was predicted to be 9.2 $\mu g/m^3$ by Gelhaus and 7.1 $\mu g/m^3$ in the EIS. Both concentrations are above the PSD Class I standard (for SO_2 of 5 $\mu g/m^3$). Predictions with 60 and 90

Table 1

EMISSION DATA AND STACK PARAMETERS

Parameter	AQB 1980[a]	EIS
Emission Rate g/sec[b]		
SO_2	1352.2	1352.2
Particulates	56.7	56.7
NO_x	453.6	453.6
Additional Pollution Control		
SO_2, percent control	Zero	Zero, 60, 90
Particulates, percent control	99	99, 99.5
NO_x	Zero	Zero
Stack Parameters[c]		
Stack height, m	121.9	122[d]
Exit Gas Velocity, m/sec	24.2	24.4[d]
Stack Diameter, m	7.1	7.4
Exit Gas Temperature, °K	425.2	424[d]

[a] Data are from the modeling report (Gelhaus, 1980).

[b] The derivation of these rates is discussed in Section 5.1.2 of the EIS.

[c] Stack parameters in the EIS were supplied by EPA Region VIII personnel in Denver. The Gelhous report states that the stack data were derived from EPA Region VIII data but does not state why different values were used.

[d] These values agree with Appendix E: Plant, Mine and Reservoir Operations International Poplar River Water Quality Study 1979 p. 5-75. The stack diameter given in Appendix E is 7.11 m.

Table 2

ESTIMATED MAXIMUM POLLUTANT CONCENTRATIONS IN MONTANA FROM THE POPLAR RIVER POWER PLANT

(Concentrations in micrograms per cubic meter)[a]

Pollutant	Time Period	Power Plant Size		NAAQS[b]	Montana AAQS	PSD Class II
		600 Mw	1200 Mw			
Sulfur Dioxide	1-hour	400 (214)[c]	800 (428)	--	1300	--
	3-hour	166 (96)	332 (192)	1300	--	512
	24-hour	46 (28)	92 (56)	365	265	91
	Annual	1.6 (2.4)	3.2 (4.8)	80	55	20
Nitrogen Oxides	1-hour	134 (74)	268 (148)	--	564	--
	Annual	0.6 (.79)	1.2 (1.6)	100	94	--
Particulates	24-hour	2.0 (2.6)	4.0 (5.2)	150[d]	200	37
	Annual	0.06 (.2)	0.12 (.4)	60[d]	75	19

[a] Note - higher concentrations have been predicted using a fumigation model. However the duration time remains uncertain.

[b] National Ambient Air Quality Standards.

[c] Numbers in parentheses are predicted concentrations in the EIS.

[d] Secondary Standard.

Table 3

POPLAR RIVER AREA ESTIMATED SULFUR DIOXIDE CONCENTRATIONS 600 Mw FACILITY (Gelhaus, 1980)

Direction[b]	1-Hour Maximum Concentration[a] (Values in micrograms per cubic meter) Distance Downwind (km)				
	10	18	30	42	50
100	176	140	90	68	64
110	158	112	86	86	82
120	196	400	76	64	64
130	176	138	80	68	64
140	176	118	216	146	64
150	198	130	216	186	168
160	196	118	164	156	146
170	168	128	84	80	106
180	176	118	76	64	70
190	166	102	84	146	86
200	138	112	158	146	152
210	196	112	110	182	152
220	196	112	84	128	118
230	178	112	76	114	134
240	196	94	76	252	224
250	182	112	314[c]	252	220
260	148	108	314[c]	252	236

[a] Note - Higher concentrations have been predicted using a fumigation model; however, the duration time remains uncertain.

[b] Direction in degrees, 0 or 360 = North.

[c] These values would occur in Canada as the border is about 35 km (22 miles) from the power plant site in this direction.

Table 4

PREDICTED MAXIMUM SO_2 CONCENTRATIONS AT THE FORT PECK INDIAN RESERVATION BOUNDARY POWER PLANT SIZE

Time Period	Allowable PSD Increment Class I	300 MW						600 MW						1200 MW					
		Percent Control						Percent Control						Percent Control					
		0		60		90		0		60		90		0		60		90	
		A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B
3 Hour	25	49	12.5	20	5	5	1.2	98	25	39	10	9.8	2.5	196	50	78	20	2.0	5
24 Hour	5	11	5	4.4	1.8	1.1	0.5	22	10	8.8	4	2.2	1	44	20	17.6	8	4.4	2
Annual	2	0.4	0.5	0.16	0.2	0.04	0.05	0.8	1	0.3	0.4	0.08	0.01	1.6	2	0.6	0.8	0.2	0.2

Note: All values are in $\mu g/m^3$. Values under A are from Gelhaus, 1980. The values under A for 60 and 90 percent control are calculated values. Values under B are from the EIS.

220) Continued

Air Quality Modeling (Continued)

percent SO_2 control in the EIS (Table 3.1-2 in the EIS) show that 90 percent control would be required to meet the PSD Class I standards for SO_2 for a 1200 MW plant at both the wildlife refuge and the Fort Peck Indian Reservation. For a 600 MW plant the EIS predictions indicate that PSD Class I standards for SO_2 at the Fort Peck Indian Reservation could be met with 60 percent control, although the predicted values are within 1 μg/m³ of the standard (Table 4). The predictions by Gelhaus indicate that 60 percent control is insufficient. For a 300 MW plant, the EIS predictions are equal to the maximum 24-hour SO_2 standard while the Gelhaus predictions exceed both the maximum 3-hour and 24-hour SO_2 standards. Using 60 percent control would meet the standards based on Gelhaus' predictions. Particulate PSD Class I standards are not exceeded by either prediction with 99 percent control (Table 5).

Table 5

PREDICTED MAXIMUM PARTICULATE CONCENTRATION AT THE FORT PECK INDIAN RESERVATION BOUNDARY

Time Period	PSD Class I Increment	Power Plant Size					
		300 MW		600 MW		1200MW	
		A	B	A	B	A	B
24 Hour	10	0.46	0.4	0.92	0.8	1.84	1.6
Annual	5	0.02	0.04	0.04	0.08	0.08	0.16

Note: All values are in μg/m³ with 99 percent control. Values under A are from Gelhaus, 1980. Values under B are from EIS.

220) Continued

Fumigation Estimates

The Montana Air Quality Bureau also made calculations of SO_2 concentrations during fumigation (Gelhaus, 1980). Both Gelhaus and the EIS used Turner's equation (Turner, 1969) as shown below:

$$C_f\,(x,0,0,H) = \frac{Q}{\sqrt{2\pi}\,U\sigma_{yf}\,h_i}$$

where C (x, 0, 0, H) = the ground-level, plume centerline pollutant concentration, ug/m^3

Q = the pollutant emission rate, ug/m^3

U = the mean wind velocity, m /sec

σ_{yf} = the spread of the plume in the "y" direction during fumigation conditions, which is given by σ_y (stable) + H/8 (where H is the total plume rise), m

h_i = the inversion height, approximated as H + $2\sigma_z$, m

As shown for January conditions in Table 6, the meteorological conditions used in the two fumigation calculations were similar. In addition, the EIS included fumigation calculations under typical meteorological conditions for April, July, and October and more severe meteorological conditions with light winds and a very strong surface inversion.

A key parameter, plume rise, was not given in the Gelhaus 1980 report. Both investigations used Briggs equation to calculate the plume rise (Briggs 1969, 1970, 1972). The EPA used a value of 216 m for the typical January case. A value of 200 m was apparently used in the Gelhaus report (Personal communication 1981). Sensitivity analyses were conducted to show the variation in results due to differences in plume rise. The SO_2 concentration was computed for a plume rise 25 percent lower (150 meters) and 25 percent higher (250 meters). Results of these calculations (Table 7) indicate a higher percent change in concentrations closer to the plant. Varying the plume rise between 150 and 250 m does not explain the difference between the EIS and Gelhaus calculations.

The SO_2 concentrations from both studies are shown in Table 8. Direct comparisons are hindered since Gelhaus' calculations were made for 6 km and EPA calculations were made for 10, 20, 30 and 40 km. The input data

TABLE 6

CONDITIONS FOR FUMIGATION CALCULATIONS

Parameter	EPA	Montana	
	"Typical" January	January 1978	January 1979
Wind speed (m/s)	6.3	7	8.2
Ambient temperature (^{o}K)	256	258	260
Ambient lapse rate (^{o}C/M)	0.013	0.02	0.009
Plume rise (m)	216	200*	200*
SO_2 emission rate (g/sec)	1352.2	1352.2	1352.2

*Assumed in this memorandum

TABLE 7

SENSITIVITY OF PLUME RISE ESTIMATE

Distance Downwind (km)	Computed SO_2 Concentration[a] (ug/m^3)		
	Plume Rise=150 m	Plume Rise=200m	Plume Rise=250 m
1	8190 (+30)[b]	5744	4276 (-25)
3	3446 (+24)	2620	2080 (-20)
6	1778 (+26)	1410	1158 (-18)
10	1086 (+23)	882	738 (-16)
20	541 (+17)	451	386 (-14)

[a] Values are computed using Gelhaus' data for January 1978.

[b] Parentheses denote percent difference of SO_2 concentration at stated plume rise from SO_2 concentration at plume rise equal to 200 meters.

TABLE 8

COMPARISON OF CALCULATED SO_2 DUE TO FUMIGATION, FOR 600 MW PLANT

Month	Downwind Distance (KM)	SO_2 Concentration,[a] ug/m^3	
		EPA[b]	Montana[c]
"Typical" January	10	912	-----
"Typical" January	20	484	-----
January 1978	6	---	7,580
January 1979	6	---	5,918
"Typical" April	10	863	-----
"Typical" April	20	457	-----
April 1978	6	---	7,424
April 1979	6	---	No. calc.
"Typical" July	10	822	-----
"Typical" July	20	484	-----
July 1978	6	---	5,882
July 1979	6	---	6,060
"Typical" October	10	568	-----
"Typical" October	20	301	-----
October 1978	6	---	5,962
October 1979	6	---	4,860
Severe Meteorological Conditions	10	2,016	-----
	20	1,301	-----

[a] Ground-level, plume centerline concentrations
[b] EPA=DEIS Table 5.1-5
[c] Montana=Gelhaus, 1980

TABLE 9

COMPUTED SO_2 FUMIGATION CONCENTRATIONS (ug/m^3) FOR 600 MW PLANT

Downwind (km)	(1) Typical Jan. (EPA Assumptions)	(2) Jan. 1978 (Montana Assumptions)	(3) Jan. 1979 (Montana Assumptions)	(4) Typical Jan. EPA	(5) Severe Jan. EPA	(6) Jan. 1978 Montana	(7) Jan. 1979 Montana
1	5,767	5,774	4,903	---	---	---	---
3	2,625	2,620	2,237	---	---	---	---
6	1,465 (0.5)	1,410 (0.5)	1.204	---	---	7,580 (2.84)	5,918 (2.22)
10	922	882	753	912	2,016	---	---
20	476	451	385	484	1,301	---	---

NOTE: Columns 1, 2, and 3 are recomputed values. Columns 4 and 5 are from the DEIS. Columns 6 and 7 are from Gelhaus, 1980. Values in parentheses are in ppm.

Fumigation Estimates (Continued)

for January from the two studies were used to verify the previous calculations as shown in Table 9. Several conclusions can be drawn from these comparisons:

- SO_2 concentrations computed in this memorandum using January meteorological conditions from the EPA and Gelhaus reports are of the same magnitude at a particular distance downwind. For example, computed SO_2 concentrations at 6 km downwind are from 1,204 to 1,465 $\mu g/m^3$.

- SO_2 concentrations computed in this memorandum at 10 and 20 km downwind using EPA's January assumptions are very close to values from the EIS (e.g. 912 vs. 922 $\mu g/m^3$ at 10 km).

- SO_2 concentrations computed in this memorandum at 6 km downwind using Gelhaus' assumptions (Table III, columns 2 and 3) are a factor of 5 lower than values presented in Gelhaus's report (Table III, columns 6 and 7).

To show the change in concentration with distance, the results in Table 9 are plotted in Figure 1. The EPA severe meteorological conditions are close to estimated values for January 1979 of Gelhaus. The values at 10 km are based on the percent change with distance.

Most of the experimental tests have been made for exposures of longer durations than one hour. It is difficult to relate long and short term exposure effects. In addition, fumigation occurs over a small area at any one time and the frequency of multiple exposures at the same site cannot be predicted.

Gelhaus points out that if fumigation occurred for 15 minutes, ambient standards can be violated for short time periods. Using the EPA fumigation estimates under typical meteorological conditions and estimated ambient concentrations at 6 km ambient standards are violated for a 1200 MW plant but not for a 600 MW plant. Using Gelhaus' estimates for fumigation and ambient concentrations, violations occur for a 600 and 1200 MW plant. While this is true under certain conditions, the area involved would be small. It is also not clear that short-term fumigations events should be compared to ambient air quality standards.

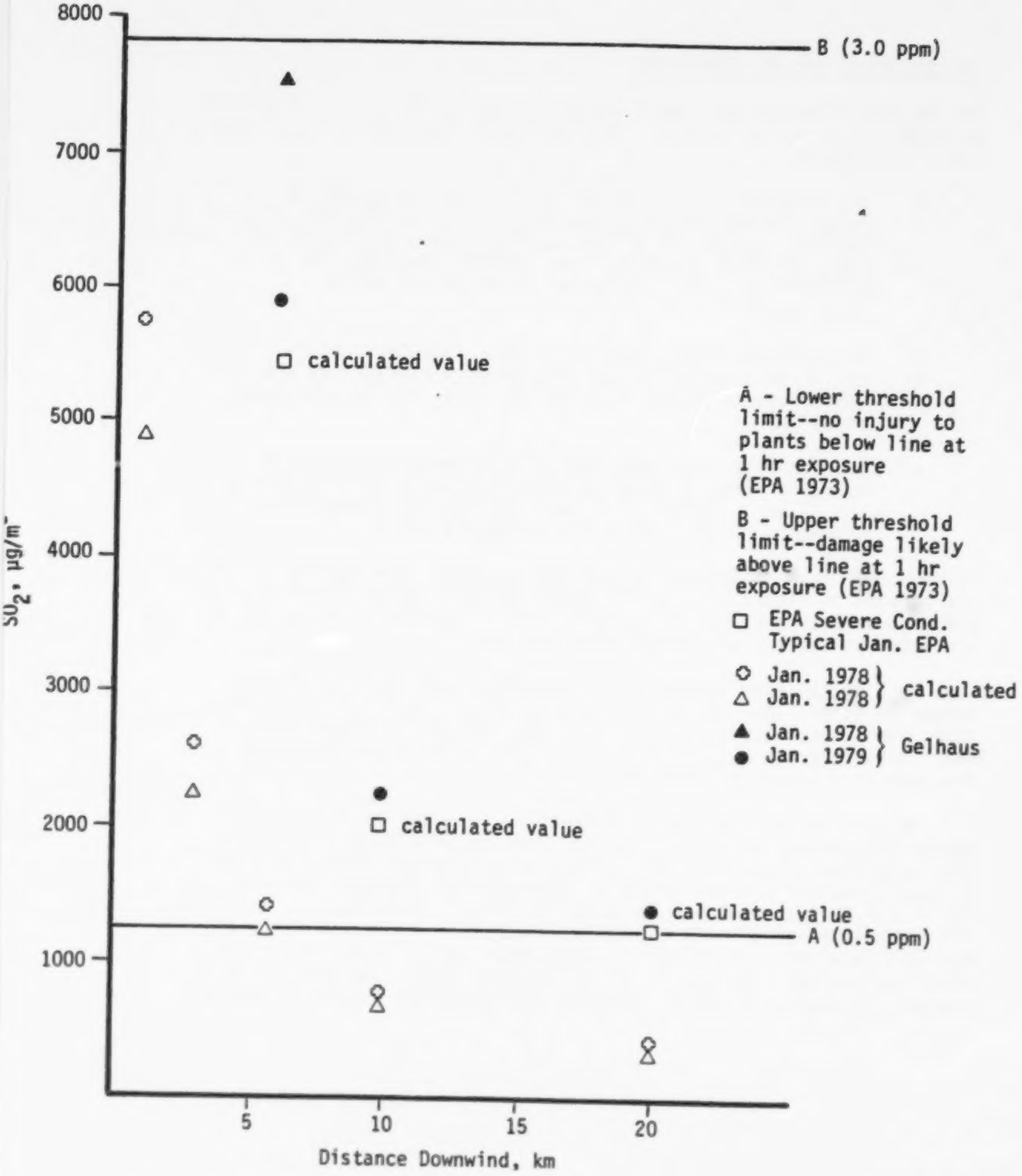


Figure 1. Comparison of Fumigation Estimates for a 600 MW Plant along the Plume Centerline

HEARING OFFICER McCLAVE: We have been going for an hour and a half. Why don't we take about a ten-minute break.

(A recess was then taken.)

Let's get started again. The next speaker will be Mr. Bill Tande, Daniels County Commissioner.

MR. TANDE: I am Bill Tande, Daniels County Commissioner, spokesman for Commissioners of Daniels County. I would like to first say that I don't think the Notice of 221) this hearing was advertised at all to the public. There was no notification in any paper or anything by the EPA.

HEARING OFFICER McCLAVE: It was published in your local newspaper.

MR. TANDE: Did you--did the EPA publish this?

HEARING OFFICER McCLAVE: Yes, sir, in your local newspaper. We had a--someone go down and check it.

MR. TANDE: There was an article in our local newspaper but not put in by the EPA.

HEARING OFFICER McCLAVE: About a month ago there was a legal notice put in your paper.

Response to Mr. Tande

221) See response 135. The hearing was advertised in the local paper.

deal with the sentence. It says, "Alternative flow apportionments were considered but the 50/50 division of flow between Canada and the U. S. with the specifications above," this 222) paragraph, "is the best from a water quality viewpoint--water quantity," excuse me, "water quantity." Can you go a little farther along? I am not sure if I understand this whole statement there made there. That seems to me that it's an assumption. There is no fact in this book I can find to back that up.

MS. SUMMERS: There was a series of apportionments which were models. Not all the modeling results are included in this book. The other types of apportionments--there was one which gave the U. S. only thirty percent of the water and Canada seventy.

MR. TANDE: This is dealing strictly with the 50/50 division of water on the East Fork then.

MS. SUMMERS: No. It's the 50/50 division of the total flow of the Poplar River between Canada and the U. S., and then it's divided up according to a schedule among the different forks, but we also considered a 70/30 split between Canada and the U. S., which is clearly not as good as the 50/50.

Response to Mr. Tande

222) The 50/50 division mentioned here and described in detail in the summary and Chapter 2 refers to the division of the total flow across the border of the Poplar River and tributaries. This apportionment is estimated to result in the least adverse impacts throughout the basin based on the present and projected water uses and impact analysis given in Chapter 5.

MR. TANDE: Is that where the 50/50 split will be made--at the international border?

MS. SUMMERS: The split is described on Page 14.

MR. TANDE: Yes, I understand that, but it still doesn't really say what I want to know.

MS. SUMMERS: Yes, it says the international border of the total flow of--

MR. TANDE: It says in the book only thirty-two percent of total Poplar River Basin rises out of Canada. Fifty percent of thirty-two is only sixteen.

MS. SUMMERS: No, fifty percent of the total flow--

MR. TANDE: Right.

MS. SUMMERS: --not just the thirty-two percent.

MR. TANDE: I just wanted to clear that up, and then on Page 2, beginning with Paragraph 5, it says, "The impoundment of water in Cookson Reservoir has resulted in improved
223) water quality on the East Fork at the international border in all seasons except spring." Where is the data to back that up?

MS. SUMMERS: Most of the data, the actual modeling results, are given in the Appendix, and there is discussion of water quality in Chapter 5.

MR. TANDE: Yes, but I don't have the Appendix, but that is quite a broad--that is an assumption. You haven't got the data for the years--you use in here mostly one or two

Response to Mr. Tande

223) The statement is based on water quality data for 1974-1977 and and modeling results which are discusssed in Chapter 3 and the Appendix.

At the last paragraph, the last line, I read in this EIS I think about four or five times it says, "Thus, no impacts
224) were predicted on any rare and endangered species," and I ask the question. Are there any in this area except maybe the farmer, but is there any endangered species in this area?

HEARING OFFICER McCLAVE: Does anybody know if there are any endangered species in this area?

MR. GRIEB: There were no rare and endangered species identified in the state reports that were conducted by Montana Parks and Game Department--Fish and Game Department.

MR. TANDE: Just reading this one summary here, it's

in the book about three or four times, and I always wondered if there is something here, because it's referred back to about three or four times in the book.

HEARING OFFICER McCLAVE: It says there were no impacts predicted.

MR. TANDE: That's right. How can there be any impacts if there are none here?

HEARING OFFICER McCLAVE: Therefore, none were predicted--because it's a requirement of the law. Are there any impacts on the rare and endangered species? That's why the thing was written.

Response to Mr. Tandy

224) Rare and endangered species which could inhabit or pass through the area are listed in Appendix A-6.

MR. TANDE: To return to the one we first started here, we talked about management of irrigation. This valley is a natural polluted valley, because this whole river 225) system--you show me a number of trees, and I got as many fingers on my hand as the number of trees growing along this river basin, and to irrigate in this valley and most of our land we have to have a flushing effect. You have to have a flushing effect in the East Poplar to wash away the TDS, total dissolved solids, the boron. Otherwise it becomes saturated, so when the dam was put in there was no flushing effect anymore. This flushing effect has never been dealt with in this book that I could find, and that is one of the major things of most irrigation projects on the river to be dealt with is the flushing away of the boron.

Response to Mr. Tande

225) The removal of channel sediments by high flows and the removal of salts, sodium, and boron by leaching are discussed in the EIS.

where a layman can understand this, this book, and I think the book is put very poorly across. I think everything in here is--it seems to me somebody made all the tables up and then somebody else wrote the summary, but the summary doesn't even really go with all the tables. I will get back to the tables in just a minute and I would like to point out just a few mistakes that I have found or other people have found and brought to my attention.

First of all, in here it says there are only two 226) schools, elementary and high schools, in this county. There are three. Peerless, Montana, has an elementary school and high school, so that makes three.

HEARING OFFICER McCLAVE: Where?

MR. TANDE: Peerless, yes, and that in here you have got--your land acres are completely wrong as far as the data I could find. You have got the total acres in Daniels County is about two thousand acres off, and I would think that a simple thing like that could be done right, and the irrigated acres in this county are off.

HEARING OFFICER McCLAVE: How far--what direction are they off? This is the Draft. We are trying to correct it. You say it's two thousand acres off?

MR. TANDE: It's about two thousand acres off.

HEARING OFFICER McCLAVE: I mean is it too large or--

MR. TANDE: Total acres in this county are 910,080

Response to Mr. Tande

226) Appendix p. 130 changed to include schools in Peerless, Montana.

acres. I believe the book said was it nine hundred eleven
227) thousand some acres, and on Table 4.3-3, Page 34, you have got
the total irrigated acres in Daniels County in 1975 as
twenty-five hundred acres. It says all hay. The IJC had
3912.5 acres, and if we go into our county assessor's office
there is over ten thousand acres.

You refer here--in this irrigated acres you go back
to wild hay, producing wild and alfalfa hay. I think the main
mistake was made here--the wild hay classification of land.
There are three different classifications of irrigated hay
land in the State of Montana. Daniels County has three of
them, which they classified as irrigated, wild hay and G2B
type land. The wild hay land is--number of acres is 9,476
acres. This is irrigated land, but it has not--it's been
irrigated, changed the species of the grass, it's produced
more tonnage and it has not been converted to alfalfa, seeded
back to alfalfa, but it still is irrigated land, and the G2B
land there is 33,760 acres, which is sub-irrigated, and it's
228) flood irrigated by natural flow, and this is not even considered in here.

229) As I stated before, the IJC said there was 3912.5
acres, and I pointed out to them that this is wrong, so this
makes all--all your economic impact tables in this EIS are in
error. They don't mean a thing, because you use twenty-five
hundred acres where you aren't even close, so I not only say

Responses to Mr. Tande

227) Data on irrigated acres in Daniels County vary by source selected. The Census of Agriculture reports 2,016 acres irrigated in 1974. The Montana State Department of Revenue reports irrigated acreage as 610 acres in 1974 and 2,029 acres in 1978. The Montana Department of Agriculture reports irrigated acreage as 2,500 acres in 1975, 2,900 acres in 1976 and 1,700 acres in 1977.

Apparently there is a conflict in the definition of what constitutes irrigated land. Wild hay lands are not reported as irrigated in other sources.

Grazing land is classified according to its carrying capacity. G2B is slightly better than average grazing land in Daniels County Land is classified as G2B based on a combination of soil and other factors. It is generally not a cropland and may or may not be affected by flows in the Poplar River. So there is a possibility that the animal units supported by G2B lands could be reduced by the apportionment.

It is not possible to estimate accurately impacts on grazing lands without a detailed study of soils and sources of moisture. However, we can indicate the limits of the problem. If G2B lands amount to 33,760 acres, they constitute approximately 10 percent of the 325,000 acres of pasture and range lands in Daniels County. G3 lands require 28 to 37 acres per animal unit and G2B lands require 22 to 27 acres per animal unit. The 33,760 acres of G2B lands will carry approximately 1400 animal units. If all are affected by the apportionment and reduced to G3, they could carry approximately 1050 animal units, a reduction of 360 animal units.

Using G3 lands as the average for grazing lands, the total animal unit capacity in Daniels County is approximately 10,000 animal units. Therefore, the maximum impact on carrying capacity is approximately 3%.

228) Paragraph inserted in Economic Impact Section to discuss possible yield losses on naturally irrigated lands.

229) The economic impacts of decreased irrigation water are based on existing and projected irrigated acres which use Poplar River water. Other land irrigated with other sources is not included. The tables in the DEIS are correct.

we will in no way support this Draft for final apportionment of water, because it doesn't tell the truth. It isn't right.

HEARING OFFICER McCLAVE: Can I ask you where you got these figures, sir?

MR. TANDE: The local--

HEARING OFFICER McCLAVE: The tax assessor?

MR. TANDE: Yes.

MR. DEAN: What year does that deal with? With the current?

HEARING OFFICER McCLAVE: Last year probably?

MR. TANDE: 1973. Also in this book there is no
230) impacts. We are talking about quite a few acres of irrigated lands, but there is no impact on loss of tax base. I would like to know why that isn't here, because being a county commissioner the people have got to make up the taxes and if there is a loss of tax base somebody else has got to pay for it, and it's going to be the people in this county, and that's a very important impact, and it's been completely left out of here.

About all I can say again is we cannot support this Draft in any way until the changes are made which will make it--with the tax base put in here, the loss of tax base and the right irrigated acres in this county, which would in turn make the economic impact tables different, and it will show a greater loss.

Response to Mr. Tande

230) Impacts on tax base and effect on county budget have been added to Section 5.5 of final EIS.

Apportionment on the Poplar River Basin," I found a number of deeply disturbing features, statements and predictions. Some of these disturbing aspects of the Draft EIS are outlined below:

231) The Draft EIS contains considerable irrelevant material which should be removed. For example, on Page 2 and again on Page 4 EPA points out $269,000 expenditures in the U. S. by Canadian workers plus some secondary benefits and yet fails to mention the U. S. share of approximately $750,000 spent by taxpayers to finance the "International Poplar River Water Quality Study" conducted by the IJC and fails to mention the taxpayer expense for this EIS which is estimated to be $175,000 all of which results in a net loss to the U. S. taxpayers of a few hundred thousand dollars. This is irrelevant to the main issues of the Impact--Environmental Impact Statement and this should be removed from this Statement.

HEARING OFFICER McCLAVE: We are required, sir, to see what the socio-economic impacts are. In other words, if we spend money we are required by law to put it in.

DR. SIMS: Okay. If it's required by law to put it in all the numbers should be put in.

HEARING OFFICER McCLAVE: If you would like us to calculate the cost of the $170,000 apportioned to the taxpayers--

Response to Dr. Sims

231) This material is retained as required by law. See response 196.

The statement on Page 2 that the impoundment of
water in Cookson Reservoir has resulted in improved water
232) quality on the East Fork at the international border in all
seasons except spring is not a statement of fact but rather is
an assumption. It is an assumption based on another assumption
that one year's data, 1975, represents the long-term
average.

An equally valid assumption is that the present water quality of the East Fork at the international border reflects the true average water quality of the East Fork for the period of impoundment, 1975 to 1980, and that these TDS and boron levels would be a more valid base from which to judge future degradation than is the 1975 data.

The actual operation of the three hundred megawatt unit will lower the quality of the water in the East Fork. This is consistent with EPA's statement on Page 126 that the outflow quality from the reservoir is determined by complete mixing of the reservoir and mass balance of all reservoir inflows and outflows.

233) Also on Page 126 EPA states that the quality of surface irrigation return flow was calculated at ten percent higher than the quality of the diverted water. The quality of the return flow will be much lower than that of the diverted irrigation water. Grossly invalid statements such as the one by EPA above cast doubt on the validity of the report.

If there is any validity to any of the predictions
in this report, the predicted yield reductions on Pages 132,
140 and 141, which are substantial, would be very significant
234) and is in serious conflict with EPA's statement on Page 2
which says that operation of a single megawatt unit will not
lead to significant degradation of water quality for irrigation
and other purposes.

Responses to Dr. Sims

232) The 1975 "baseline year" was chosen as a reference point, primarily for a description of pre-reservoir conditions and development. The 1975 year was not modeled and thus is not the comparison point for the projected impacts - after impoundment and historical conditions are the comparison points.

233) Substitute "concentration" for "quality".

234) This statement referred to the difference between the concentrations of parameters for the impoundment only and one power plant case. The crop yields were compared to yields with estimated soil solution concentrations.

HEARING OFFICER McCLAVE: Milt Gunderson.

MR. GUNDERSON: I am Milton Gunderson. I live on a small family farm about twenty-three miles downwind from where the plant is, and I work here in Scobey at the newspaper.

A portion of this Draft that was devoted to air pollution impacts on crops and land indicated little or no vegetation soil damage from two three hundred megawatt plants. There is conflicting evidence on this. I refer you to a paper published in March, 1979, by the Air Quality Bureau Environmental Science Division of the Montana Department of Health after a study of the Scientific and Engineering Advisory Panel on the Poplar River air quality. I believe you referred to it in some places in your Draft.

235) This report states that there would be a one to two percent crop loss, both grasses and grains, in a forty-kilometer radius around the plant.

Now, perhaps Tetra Tech feels two percent is too small to consider, but to an area that is completely dependent on agriculture this is very important.

Using present production records and prices, a one and a half percent loss in just the part of this forty-kilometer radius circle which lies in Daniels County would amount to over $400,000 a year. This loss to farmers would more than offset the economic gain predicted in the Draft for area business places. Farmers would have $400,000 less to

Response to Mr. Gunderson

235) The statement that the deposition of sulfur pollutants would result in a 1 to 2 percent crop yield loss was made in a report by the Air Quality Bureau Environmental Science Division of the Montana Department of Health (Gelhaus and Roach, 1979). The effects of SO_2 deposition on vegetation are site-specific and must be evaluated on a case-by-case basis. Our analysis which considered acute, chronic, and long-term exposures to projected ambient concentrations of SO_2 as well as the potential effects of sulfur accumulation in the soils, does not support the conclusion reached by the Air Quality Bureau. The assessment of the impacts of gaseous emissions on vegetation is presented in Section 5.6.1.1. of the EIS.

spend, and this is not nearly all the projected loss. It most probably would be well over double that figure.

Quoting from Page 22 of the Department of Health 236) paper, "It does not include the effect of pollutants other than sulfur dioxide and its derivatives." Another quote, "This estimate doesn't consider decreases in crop productivity and fertility loss of the soil caused by radical application of sulfur pollution." This, I believe, could be drastic as the years progress. I would hope that some considerable part of the Final Impact Statement would be directed to the long-range effects of the land.

The study mentioned about only for one year. There is strong evidence that the problem would multiply as the years go by, and how many years after they estimate the thirty-five years life of the plant will production from the surrounding land be lowered?

During 1977, and this report has been mentioned before, researchers from the Terrestrial Division of the EPA Corvallis Environmental Research Laboratory studied potential effects of sulfur dioxide on crops and native grasses grown in our area. I quote one of the conclusions. 237) "Prolonged low-level sulfur dioxide exposure appeared to be more of a threat to crop yields than short episodes of high exposure." Yet in this Draft the only damage even hinted at was fumigation under very stable conditions for short periods--nothing adverse

Responses to Gunderson

236) The long-term effects of elevated SO_2 concentrations including the buildup of sulfur in soils and soil acidification have been addressed in the EIS (Section 5.6.1.1).

237) The statement--prolonged low-level sulfur dioxide exposure appeared to be more of a threat to crop yields than short episodes of high exposure--was not presented as a conclusion in the report published by the Terrestrial Division of the EPA Corvallis Environmental Research Laboratory (Response of selected small grains, native range grasses and alfalfa to sulfur dioxide, Wilhour et al. 1979). Rather, this statement represents the Scientific and Engineering Advisory Panel's (Air Quality Bureau Environmental Science Division of the Montana Department of Health) interpretation of the results of the aforementioned study. The study conducted by the Corvallis Environmental Research Laboratory (CERL) did indicate that yields of Duram wheat and barley decreased when treated weekly for 12 weeks with 72-hour exposures to SO_2 concentrations as low as .10-.15 ppm (270-400 $\mu g/m^3$). However, predicted maximum SO_2 concentrations during any 72-hour period in the Poplar River Basin are substantially below 0.10 ppm (270 $\mu g/m^3$).

One of the authors of the CERL report (Wilhour et al. 1979), G. E. Neely, was contacted concerning this statement of prolonged low-level sulfur dioxide exposure. He indicated that if one considered weekly exposure to SO_2 treatments of 0.10 and 0.15 ppm for 72 continuous hours as prolonged low-level sulfur dioxide exposure, then the statement in question has some merit since the CERL study also showed that exposure to 1.2 ppm or 3240 $\mu g/m^3$ (short episode of a relatively high exposure) had no effect on yields of the small grains and alfalfa. However, it must be emphasized that the exposure durations and concentrations, which resulted in loss in plant yield in the CERL studies, are substantially greater than predicted SO_2 levels associated with the operation of two 300 MW power plants by Saskatchewan Power Corporation. Moreover, the results of the CERL studies cannot be used to predict the effects of long-term exposure of crops to the predicted increases in ambient SO_2 concentrations.

In conclusion, I found the report very technical and thorough to the point where it is hard to understand. It was difficult to trace down one subject because the material was scattered throughout the report. 238) One 172-word paragraph was printed twice in the same section on two different pages--Page 201, the last paragraph, and Page 204, the third paragraph, the same thing. This makes for a lengthy report but hardly easy to read.

239) I found some of the graphs hard to understand --for example, on Page 205, and some maps inaccurate--Page 11 of the Appendix.

The report states on Page 125 that the winter flow of the upper Middle Fork is absolutely zero fifty percent of the time. 240) I find this statement untrue. I have been up and down this river in the dead of winter many times in the last twenty years and I have yet to find a time when we didn't have some stream flow. I have also talked with many of the older ranchers who have wintered cattle and sheep on the Middle Fork for years using only water from the river for their stock. If it were true that the river only flowed fifty percent of the time their herds would have never seen spring.

It makes me wonder how many more inaccuracies do we

Responses to Halverson

238) The subject paragraph on page 204 has been deleted as originally intended.

239) Keys and graphs have been revised where necessary to improve readability. Errors have been eliminated.

240) The zero flows on the West Fork were for the case of a 1 in 10 year dought. Zero flow on the computer results means less than 0.004 hm/month or 3.2 ac-ft/month. In addition the Poplar River Task Force (1976, Appendix B, p. G-6) stated that flows were assumed to stop on the West Fort at the International Boundary during December to February under natural conditions. Flows on the Middle Fork at the boundary were assumed to stop from January through March unless an early thaw occurred for that year. A note has been added to the beginning of the modeling section to explain this.

have in this report. I would recommend, gentlemen, that before you make a final decision on stream flow apportionment and water quality standards that you take a closer look at the real problems.

Thank you. Would you like a copy of that?

HEARING OFFICER McCLAVE: Lee Humbert.

MR. HUMBERT: My name is Lee Humbert. I live northwest of Scobey near the middle fork of the Poplar River. I would like to begin by making some general comments about the Statement followed by some comments about ground water, which is an area of specific concern to myself and others living near the international boundary.

241) The Statement which is purported to address several flow apportionment alternatives on the Poplar fails to mention Boundary Waters Treaty of 1909, specifically the articles pertinent to downstream users. This treaty should be central to any discussion of apportionment or use.

The language of the Statement is very technical and
difficult for the layman to understand. This is contrary to
242) the EPA regulations for compiling such a document. An example
of this are the wind-rose charts on Pages 148 to 151 of the
Appendix. These apparently simple graphs can be a nightmare
for a layman to decipher. There is no keys for the explanation
of their proper interpretations.

There are a number of obvious inaccuracies in the

Responses to Mr. Humbert

241) See response 240.

242) The detailed air and water quality modeling and analyses of impacts are complex technical subjects and need to be treated thoroughly. Changes have been made to make the EIS more understandable. These include adding an expanded summary in non-technical language, and a description of the scenarios in the summary; moving the map of river stations to the summary; and adding more detailed keys or footnotes to tables and figures.

(282) document including first the map on Page 22 of the Appendix which has counties misnamed and geography misrepresented; second, the statement on Page 138 of the Appendix which reads,

(283) "The only schools in [illegible] County are located............ [illegible]." The people in [illegible] would take exception to this statement. Third, the statement on Page 125 of the Report document dealing with the winter flows which states, "The winter conditions on the upper [illegible] Fork, Station 4, are shallow with zero flows fifty percent of the time." I have lived on the upper [illegible] Fork nearly all my life and I have

(284) yet to see the river with zero flow fifty percent of the time in the winter. My father, who has lived there for nearly fifty-five years--he also states this statement is obviously false.

My point in noting these obvious inaccuracies is if they are so apparent to a layman how many inaccuracies in the technical scientific gathering and interpretation would also be obvious to an expert?

I take exception to Sections 5.1.1.1. and 5.1.5.2. of Pages 5-1 and 5-8 of the main report. These sections state

(285) potential impacts and attempt to give funding income to the residents. They do not state who will pay the cost of implementing these provisions, however.

Area decreasing and the effective lowering of the water table has been predicted by the Ground Water Commission

Responses to Mr. [illegible]

(282) The map names have been corrected.

(283) Sentence has been changed adding the schools in [illegible].

(284) The zero flows are model results and mean less than 0.028 cubic hectometers per month (0.2 ac-ft). See response [illegible].

(285) NEPA regulations require that mitigating measures for impacts be discussed in the EIS. A discussion on costs has been added to Section 5.5.6.

of the U.S. They say it will lower the water table at the international boundary 2.3 feet in thirty-five years. I think these figures can be disputed. A prediction of even a greater lowering of the water has been anticipated. This is not, however, even discussed in the Impact Document. This (407) lowering of the water table would have an obvious impact on the farmers and ranchers near the boundary who depend on springs and sub-irrigated pastures for livestock production.

There has been an increase of saline seep from rais-ing of the water table below the reservoir. This impact has not been discussed in the Statement. I would like to know if drinking water and surface water quality has been addressed. The underground water contains a much higher volume of TDS including mercury as well as other constituents than the surface water in [illegible]. It may also contain hydrocarbons (408) which are dangerous to health from the rapid depletion from the coal-bearing aquifer. Another question is will the surface water be contaminated by the exchanged ground-water aquifer and be polluted by precipitation run-off, the mine spoils and open pits?

In closing, I think this Statement should be reconsidered to determine the extent of the [illegible] in [illegible] and then be revised before any final approval. There has been a great volume of data generated concerning the Poplar River in the past few years. Perhaps if more of the

Responses to Mr. Humbert

407) The analysis of impacts in the EIS is restricted to the U.S. side of the border. A decline in ground water of 2.3 ft in 35 years is 0.8 inches per year and is thus not a significant decline. A discussion has been added to the Water Quality Impacts section (Section 5.2.4) on impacts of the lowered ground water level due to mine dewatering and the reduced recharge from spring runoff along the Poplar River.

408) The mine dewatering release to the Cookson Reservoir and East Fork were considered in the MME model used for scenarios 6A and 6B. Inflow to the Cookson Reservoir and East Fork considered by the MME model included mine dewatering discharge, ground water seepage, runoff, direct precipitation, tributary inflows, power plant discharges, and ash lagoon seepage.

studies are generated and completed in the local area rather than in Denver or California it would improve the credibility of the reports.

Thank you.

HEARING OFFICER [illegible]: Eddie Lund, Scobey.

MR. LUND: First of all, my name is Eddie Lund, and I live on a ranch near Scobey, and I am here to address the

(003) mercury contamination issue. The Draft EIS has done everything but overlook it.

Page 44 in the EIS points out that mercury levels in walleye taken from the Cookson Reservoir exceeds the Canadian and U. S. standards. The report noted levels of up to 1.5 parts per million. However, the Saskatchewan Power Corporation report on mercury contamination showed a maximum of 1.71--over three times the Canadian standard and well over the U. S. standard of one part per million.

The EIS goes on to say that mercuric acetone is widely used as a fungicide for treatment of wheat seed throughout the basin. EPA, of all people, should know that mercury seed treatment has been banned in the U. S. and Canada since the early seventies. The seed treatment theory was first proposed by the EPA, and it's disappointing that the Draft EIS has echoed this lame excuse.

On the following page of the EIS, it is noted that mercury levels in all but the main stem have exceeded the

Response to Mr. E. Lund

003) With regard to mercury problems, the EPA and USGS are pursuing this problem. The text of the DEIS has been changed adding other possible sources. Mercuric acetone is still being used--see response 102. A detailed field investigation would be required to determine the sources of mercury. Such a study is outside the scope of this project but is strongly recommended. In addition, a long-term monitoring program is recommended which would determine water quality and concentrations of selected toxics in fish tissue. These recommendations have been added to the EIS Summary.

In agriculture, among other elements we depend on clean air for maximum productivity. Air quality laws, both federal and state, are written to protect human health, not agriculture. The long-term effect of low levels of air pollution on agricultural crop levels that meet the law are not easy to document. It is known, though, that the effects are crop yield reductions.

One study, for example, showed reduction in wheat yields of up to fifteen percent from sulfur dioxide levels about half the present federal standard. The EIS, however, contains only simplistic and unsupported statements on this question.

250) On Page 17 the EIS says, "The predicted maximum concentrations and duration of exposure are also below acute and chronic threshold limits for the most sensitive plant species." The EIS fails to say what those thresholds are and what plant species. The fact is that there are no known thresholds for damage from long-term low-level pollution.

251) The EIS says there will be fumigation near the acute thresholds without saying how close the fumigations will be or how they will affect the agriculture.

252) There is nothing in the EIS about the effects or possible effects of acid rain on crops or on water quality. Sulfur dioxide emission can cause acid rain hundreds of miles from the source. It is conceivable that acid precipitation caused by the [illegible] Power Plant could affect farming operations even farther from the plant than our farm near [illegible]. No one can be sure that it will but neither can anyone assure us that it won't. The EIS simply does not address this question and the risk is ours.

Responses to Mrs. Waller

250) Acute threshold exposure limits (concentrations and short-term exposures below which no visible injury is observed) were presented in the EIS for three categories of SO_2 sensitivity in plant species (Figure 5.6-1). Reported acute and chronic threshold limits to gaseous exposures of important native plant and cultivated species in the impact area were also presented (Table 5.6-1).

It is correct that there are no known thresholds for damage from long-term low-level exposures to gaseous emissions. For this reason, the analysis of long-term effects of SO_2 emissions presented in the EIS concentrated on the secondary effects of elevated ambient SO_2 concentrations such as soil acidification.

251) Fumigation concentrations are presented in Section 5.1.5.4 and impacts on crops are discussed in Section 5.6.

252) The impact of primary concern associated with the acid rain is not damage to aerial portions of plants, but the acidification of soils and the subsequent deterioration in the soil quality. Soil acidification, as was pointed out in the EIS, can occur through both dry and wet (acid rain) deposition of sulfur. However, based on the calculated buffering capacity of soils in the input area, it was concluded that no significant change in soil pH would occur. The potential for deterioration in water quality resulting from atmospheric emissions was addressed in Section 5.6.2 of the EIS. Based on the alkaline nature of soils and surface waters, it was concluded that there is an extremely low potential for surface water acidification in the impact area.

profits of up to fifteen percent from sulfur dioxide levels above half the present federal standard. The EIS, however, contains only simplistic and unsupported statements on this question.

(253) On Page 38 the EIS says, "The predicted maximum concentrations and duration of exposures are also below acute and chronic threshold limits for the most sensitive plant species." The EIS fails to say what those thresholds are and what plant species. The fact is that there are no known thresholds for damage from long-term low-level pollution.

(254) The EIS says there will be fumigation near the acute thresholds without saying how close the fumigations will be or how they will affect the agriculture.

There is nothing in the EIS about the effects or possible effects of acid rain on crops or on water quality. Sulfur dioxide emissions can cause acid rain hundreds of miles from the source. It is conceivable that acid precipitation caused by the Poplar River Power Plant could affect farming operations even farther from the plant than our farm near [illegible]. No one can be sure that it will but neither can anyone assure me that it won't. The EIS simply does not address that question and the risk is there.

Similarly, the EIS neglects the potential problem of radioactivity. Studies of power plants burning lignite in Texas show they emit the same level of radioactivity as a

Responses to Mrs. Waller

253) The DEIS presented a detailed discussion of SO_2 effects on p. 171-175 including a summary of experimental data on threshold levels in Table 5.6-1 plant species.

254) Estimated SO_2 concentrations during fumigation at between 10 and 40 km from the plant are shown in Tables 5.1-4 through 5.1-7. The maximum concentration using very conservative assumptions is estimated as between 1.0 and 1.5 ppm as discussed on p. 174 of the DEIS. This level could cause some foliar damage to very sensitive species if exposed for more than 1 hour. Fumigations are of short duration (Portelli, 1975) and thus are not expected to cause damage to crops. Prediction of when and how often fumigation will occur at the same location is subject to changes in meteorlogical conditions. In addition estimates of fumigation concentrations depend on meterological conditions and thus change with time and location.

255) Similarly, the EIS neglects the potential problem of radioactivity. Studies of power plants burning lignite in Texas show they emit the same level of radioactivity as a normally-operating nuclear plant of the same megawatt capacity. The same study says the problem would be worse with North Dakota lignite, because it contains more radioactive material. The lignite in Saskatchewan at Coronach is even higher in radioactivity than North Dakota lignite.

Again, I can only make a guess at the magnitude of this problem, because the EIS does not address that concern either.

256) It is also silent on the effects of the existing reservoir and strip mine on ground water and saline seep.

Although the EIS is difficult to digest, one conclusion seems safe to me. The proposed apportionment will seriously damage downstream water users.

The EIS makes no mention of the Boundary Waters Treaty which prohibits the degradation of trans-boundary 257) waters to the detriment of users across the border. Canada violated that treaty by constructing Morrison Dam and Cookson Reservoir in the first place.

Now, the State Department seems to be trying to ratify the violation of that treaty. This EIS merely glosses over the impact of the Poplar River Power Project on agriculture in Montana in order to excuse violation of that treaty. If the EPA and the State Department will not protect Northeastern Montana interests through the Boundary Waters Treaty then who will?

Responses to Mrs. Waller

255) Emissions of radioactivity from nuclear power plants must meet federal and state standards. The emissions from this power plant are not expected to exceed these standards.

256) The EIS was directed specifically to impacts in the U.S. part of the basin only of flow apportionment and power plant operation not reservoir construction. A discussion on ground water and saline seep has been added to Chapter 5 for the U.S. part of the basin.

257) The Boundary Waters Treaty is discussed in the revised Chapter 2. A detailed discussion of impacts on agriculture is given in Chapter 5. Whether the treaty has been violated is a decision of the courts not the EIS.

Thank you.

HEARING OFFICER McCLAVE: Thank you.

Gerry Farver.

MR. FARVER: My name is Gerry Farver. I live six miles below the confluence of the east fork and middle fork of the Poplar River in the Poplar River Basin. I represent the irrigators along the Poplar River above the Fort Peck Indian Reservation.

My comments are going to be directed towards the water quality as it affects the irrigators in Daniels County. On Page 139 of the Environmental Impact Statement Draft the maximum yield reduction for Scenarios 4A and 8A for present yield for alfalfa is forty-eight percent, wheat thirty-five percent, barley fifty-one percent and oats eighty-seven percent. 258) The Draft does not make it clear if this yield reduction is for one year or five years or is, in fact, a geometric progression. Regardless, the loss in income is more than enough to put most farmers or ranchers out of business.

In the summary on Page 2 of the Draft it states that the operation of a single three hundred megawatt unit will not lead to significant degradation of water quality for irrigation and other purposes. Is a forty-eight percent reduction in alfalfa yield and a thirty-five percent reduction in wheat yield not significant?

I refer to Article IV of the 1909 Boundary Waters

Response to Mr. Farver

258) Crop yields given are for one year only. However, scenarios 4A and 8A included the ash lagoon decant and thus are severe. [illegible] stated that the decant will be recirculated. [illegible] linings of [illegible] ash lagoons are already in place. Thus, these severe conditions will not occur. The statement in the summary referred to the difference in water quality for one 300 MW unit with decant recirculation or post impoundment conditions (scenarios [illegible] and [illegible], respectively).

Treaty between the United States and Canada, the last paragraph of which reads as follows: "It is further agreed that the waters herein defined as boundary waters and waters flowing across the boundary shall not be polluted on either side to the injury of health or property on the other." The above [illegible] reduction would certainly be a violation of the Boundary Waters Treaty. It is definitely an injury to my property.

[illegible] On November 1st of 1979 I started taking monthly water samples for standard analysis from five different sites along the east fork and middle fork of the Poplar River and also below the confluence of these two rivers. The samples were and are being sent to the testing laboratory at Montana State University, Bozeman, and the results are sent back to the Daniels County extension agent and myself.

I tried to compare boron concentrations from my water sample results with the results that appear on Page 128 and 130 of the Draft. This Draft is supposed to be written so that a layman could read and understand its contents. The graphs are very confusing and they lack the labeling so that a lay person cannot understand it. The whole Draft in general is poorly written. [illegible]

Response to Mr. Farver

[illegible] The Boundary Waters Treaty is discussed in the revised Chapter 2. A detailed discussion of impacts on agriculture is given in Chapter 5. Whether the treaty has been violated is a decision of the courts not the EIS.

[illegible] The problem may have been the units of Mr. Farver's data. At low levels "ppm" is approximately equal to "mg/l".

On Page 131 of the Draft it states and I quote, "The seasonal water requirement for alfalfa from June to September, assuming that in the months of April and May the soil retains sufficient moisture from snow melt requiring no irrigation, is 18.5 inches." This statement is misleading and 261) incorrect. The irrigation season in Daniels County is from April through September. The early April irrigation with its low TDS content is necessary to flush out the salts and boron accumulated from the previous year's irrigation. The Draft is giving a misleading assumption saying that the snow melt is sufficient moisture. It is not. The ground is usually frozen when the snow melts so that between the actual run-off and evaporation little if any moisture is actually being utilized as a flushing action which is badly needed.

I would like to conclude my remarks by saying that if both countries would recognize and abide by the 1909 Boundary Waters Treaty we would not have a problem today or in the future.

In cross-examination before the International Joint Commission here in Scobey a Canadian testified that the technology now exists that they could release cleaner water than now flows in the Poplar River but the process would cost a lot of money.

When the automobile industry had to put seat belts in every automobile they turned out they merely passed the cost on to the consumer. Why can't Saskatchewan Power Corporation use the available technology to put scrubbers in the stack and whatever else is required to clean up the air and the water and pass the cost on to the consumer?

Response to Mr. Farver

261) The irrigation season has been changed to include May in our calculations.

[illegible] project [illegible] [illegible] approximately $100 per week when they spend a weekend in Scobey or Daniels County there are no precise estimates as to the amount really spent. There are perhaps some businesses which would benefit from these few construction workers but it is interesting to note that the $100 spent has been broken down in this way: Seventy dollars for hotel room and entertainment and the remaining thirty dollars on other purchases.

Now, it's quite possible that there are greater numbers of the workers going on to Plentywood in Sheridan County because they do have a twenty-four-hour border crossing. They have substantially more retail stores and services available than Scobey and entertainment which is not available in Scobey. Our border north of Scobey is limited in hours being open from nine a.m. to six p.m. from October the 1st to May the [illegible] and from May the 15th to September the 30th the border is open from eight a.m. to nine p.m., so that is very limiting.

262) Now, an influx of single men always necessitates added services of the community such as law enforcement, sanitation services and et cetera. These services in turn are paid for by the taxpayers of Daniels County. These added costs would negate any of the minor increase in sales from these workers.

It has been found that sales vary considerably from year to year in Daniels County and that is mainly due to the farm income which is subject to weather conditions and prices for farm products. Therefore, the impact of dollars spent by these workers is far less significant to Daniels County than the income of farmers of the county.

Because the main source of income in Daniels County is from the sale of farm products and related businesses it should be noted that probable results of the Poplar River project will be acres taken out of production.

263) One of the most dramatic effects can be seen today on several farms bordering the United States-Canadian border just south of the project--mainly saline seep. It is directly affecting hundreds of acres already. This means less production from this land, less income from the land for the land user and will result in the land being declared unproductive and would have to result in the tax base for this land being lowered. This would be a chain result from the land user income down to our county revenues all being drastically lowered.

264) There has been projection of an intent of a large increase in the number of acres to be irrigated in the next ten years. An increase in demand for farm seasonal workers is likely to occur if the growth in irrigated land takes place as projected.

Apportionment would have a tremendous effect on the

Response to Mrs. Danielson

262) Reports of additional service costs were not uncovered by the [illegible] preparers. Such costs are difficult to estimate even when they were known to occur.

Responses to Mrs. Danielson

263) Possible impacts on the tax base have been added.

264) The irrigation systems contemplated are largely automatic and require little labor. A change to irrigataed agriculture may only serve to slow the historical decrease in local farm employment.

most of the original settlements in this area were on the Poplar River. Hence, I think you can understand the concern.

Also what I would like to relay to you that our argument is not with our good friends to the north, the Canadian citizens. Our argument has always been with the Saskatchewan Power.

Many of my questions have been answered by listening to this testimony here this evening, but the gentleman on the end who stated there would be no impact of dry-land agriculture, dry-land farming, from fumigation or from SO_2 build-ups 265) that appears to me to be a dichotomy, because just to the south of us, the Knife River down here by Sidney; it is required of that plant with sixty megawatts to have scrubbers to protect the environment. I think that's--something isn't quite right there.

I have visions and I have feelings that the Poplar River is a marginal river in the first place and to take out half the water and you come to twelve hundred megawatts is there going to be enough water for anything? I am still convinced that you have pre-empted all the irrigation that is planned on the Fort Peck Reservation in Roosevelt County and I think that this project will pre-empt any future development and anything yet to come in this area. The negative impacts that you have stated here in the EIS and in this study is just about exactly what we here in this area have been telling the

---

Response to A. Lund

265) Air quality controls may be required to meet the U.S. and/or State of Montana air quality standards. The standards are designed to prevent damage to human health, agriculture, and biota. The difference to the Poplar River case is that the U.S. and Montana standards do not apply to the Canadian power plant. There are violations of these standards in the U.S., for a power plant of 600 MW's or more.

[illegible] the least flow [illegible]. You are right on.

Thank you.

HEARING OFFICER McCLAVE: Thank you.

Bill Cromwell.

MR. CROMWELL: Members of the panel, my name is Bill Cromwell. I am Vice Chairman of Three Corners Boundary Association and Chairman of the Daniels County Planning Board, and I live about twenty-nine miles from the power plant right about the end of one of those lines that you have drawn on the [illegible].

My main area of concern in the Draft EIS on the impact of Canadian power plant development and flow apportionment on the Poplar River Basin is the air quality segment.

266) As Bill Gunderson mentioned, there is no mention of the issue paper by the Scientific and Engineering Advisory Panel on Poplar River air quality. This paper raised questions about the coal test burns, sulfur retention, meteorological data, emission rates and also calculated higher negative economic impacts to agriculture.

267) Monitoring and modeling of the emission rates are critical instruments in determining the air quality impacts. Constant monitoring of the emissions continuously is the only sure way of determining the point source air pollution of the Poplar River Power Plant. Additional monitors in the main plume areas [illegible] are also essential to show the hourly and

Response to Mr. Cromwell

266) The Issue Paper by Gelhaus and Roach was discussed on p. 173 of the EIS.

267) The agreement between Saskatchewan and Montana covering water and air quality monitoring and joint transfer of data was set up in September.

---

daily SO_2 concentrations.

268) Modeling was done using meteorological data from the Glasgow area, I believe some from Scobey, but it was indicated in this Draft that the modeling would have to be rerun using the Scobey meteorological equipment which was just installed about a year ago. The meteorological transportation of emissions from the power plant may be different than that used with the Glasgow data. The diffusion of the plume may be changed due to different air dispersion. The emission rates of sulfur dioxide may also vary widely due to differences in coal analysis.

The second set of coal samples received from Canada--I believe that was the one received in March or May of '77--I would have to check that--was different coal than the first set according to the Scientific and Engineering Panel. This raised the question of how much other coal analysis will vary and how it can be averaged. Monitoring time limits because of these variations should be extended.

More sampling of area vegetation should be taken more frequently such as the beginning of the growing season, during development of bud and blossom stage, seed production stage and at near maturity of the plant. Notice should be taken of any changes which might occur in plant species due to additional stresses. Different varieties of plant species may appear which are more tolerant of nitrous oxide and sulfur

Response to Mr. Cromwell

268) See response 220 for comparison of modeling results.

entitled to prevention controls as other Montanans.

At Colstrip Montana Power coal-fired power plants burning sub-bituminous coal with almost twice the Btu's, that is ten thousand as compared to fifty-eight hundred at Coronach, with the best available technology is releasing about [illegible] tons of sulfur dioxide per year. That's a comparable sized unit of seven hundred megawatts, I believe, and this project at Coronach was held or this project at Colstrip was held up by the EPA to install better emissions controls. [illegible] percent. However, EPA seems to be giving the okay for sulfur dioxide emissions for a plant producing over ten times greater. Without the sulfur dioxide emissions control the Poplar River six hundred megawatt plant will emit about [illegible] tons per year based on coal consumption of 495,000 pounds per hour per three hundred megawatt unit. Montana's new source emissions standard of 1.2 pounds of sulfur dioxide per million Btu's is violated also by the Poplar River Power Plants emitting 1.94 pounds of sulfur dioxide per million Btu's. 269)

Evidence clearly shows that Montana has written good air pollution laws. We in Northeast Montana feel that we are entitled to the same clean air that we have enjoyed in the past and sincerely hope that our Canadian neighbors will honor our air standards.

Response to Mr. Cromwell

269) The emissions levels of several Montana and North Dakota plants are compared in the revised air quality section. The impacts of the Poplar River power plant and mitigating effects of air quality controls have been identified in the EIS.

---

detail at a later date.

Also on behalf of the Daniels County Planning Board I would like to provide you with a portion of our county comprehensive plan. I guess I have the wrong book. It has data which should be included in the Final Environmental Impact Statement. There are some errors in the Draft EIS on the inventories as other people have or will note in their testimonies. 270)

This portion of the comprehensive plan was completed June 30, 1980, and includes inventories or analyses of land use, transportation, public facilities, housing and population and economic studies, and we hope to have a whole plan completed by June 30, 1981.

Response to Mr. Cromwell

270) The Daniels County Planning Board report was reviewed and the pertinent information incorporated into the EIS.

work apparently has not been done on the agriculture, livestock and the things that deal with the land that all these people have talked about previously, and we don't want to be weighing what the possible good effects may be against the bad because that has been our bread and butter and it continues to be our bread and butter. This is what happens when the agricultural land surrounding our area is not but the short-term effects that you people have stuck in here that construction workers are going to spend in our motels and our bars.

There are a couple of things that I would like answered--one, a definition of direct and secondary impacts. 271) I wish that I could operate my business with a margin of error from 216,000 to 324,000. That leaves you an awful lot of area to work with. If I could budget my small insurance business on those type of margins of error, you know, I would have lots of room to play with, and I wish that I could do it but, unfortunately, I can't and I don't think you people should be allowed to play any bigger games than anybody else when it comes to those things, and when I look in the sections about the multiplier factors, and so on, and look at the figures that are given there they just don't add up.

I wonder, as has been pointed out several times previously, at some of the inaccuracies that were found in the Tetra Tech report whether these figures came from some

---

Response to Mr. Wolfe

271) Expenditures by Canadian workers in Daniels County could not be measured directly but had to be estimated using some crude but reasonable assumptions. To demonstrate the level of uncertainty we present an upper and a lower limit for possible impacts. The point to be made is that the impact was probably less than 10% of retail sales in 1973. No change was made to text of DEIS.

computer model that somebody came up with or whether they were gathered with the type of data that they should have been gathered with, because I did some gathering and talking with local businesses.

I went to the local bank where I would have to say probably ninety percent or better of the funds from the businesses in the impact area are deposited, and they gave me the figures from '77 to '78. Their total Canadian deposited funds had decreased by fifteen percent and in '78 and '79 they had decreased by seven percent and--'77 to '78 they had decreased by fifteen percent. That's all the checks, cash, any type of Canadian funds that come into the Citizens State Bank. Those were supplied by the vice-presidents at the bank.

I have heard some comment earlier tonight that, unfortunately, I guess, we have got the people here who we are supposed to have, but you guys got a crutch. You go out and hire private individuals, contract or service people that are supposed to do the job. You guys are only the suppliers. If you are only supposed to supply the people who are supposed to do the job then we lost there.

Again, I have dealt with consulting firms. I have been on the County Planning Board that deals with solid wastes and work with them--these people. They all--what they do they don't go out and gather raw data. They go through all the other reports they can find in the libraries and pull all the

Response to Mr. [illegible]

[illegible] It is always difficult to trace expenditure patterns in a local economy because there are few published figures. Most financial data are confidential, and publishing data for small regions may reveal information on a single firm.

income he then spends, you think of it almost as a pyramid type thing. You spend a dollar at the top and it starts spreading out.

MR. WOLFE: So using the information you have given here and a multiplier effect of 1.85 and an average figure in that gross range you have to play with, two sixteen and three twenty-four, whatever, two sixteen and three twenty-four, and you are saying roughly round the 1.8 up to two and say that the impacts have been a hundred thousand dollars spent in the area times two, which would be the multiplier comes up to the two hundred thousand dollars, then actually the report is saying the impacts have been the construction workers have spent a hundred thousand dollars in this area. Is that--

MS. SUMMERS: I believe it gives a specific amount they spent. I still have to check on the page.

MR. WOLFE: On Page 155, and I hope, because it's all contradictory, if this is the case, I tried to overlook it, 273) it says, "Using this methodology secondary impacts can be calculated. Daniels County receives approximately sixteen to twenty-four thousand dollars annually in secondary impacts." Well, then that's telling us that if we only use a mean or very, very low figure, I mean very, very low, two hundred thousand, even below the two sixteen, your lowest figure, if you are telling me the secondary factor, the sixteen to twenty-four thousand, then the actual primary impacts are in

Response to Mr. Wolfe

273) Daniels County does not receive all the secondary impacts. The secondary impacts are allocated to counties throughout the local trading area. The allocation of direct and secondary impacts is as follows:

	Low	High
Direct Expenditures	$200,000	$300,000
Multiplier 1.85		
Total Impacts	370,000	555,000
Secondary Impacts	170,000	255,000
Daniels Co.	16,000	24,000
Roosevelt Co.	53,000	79,000
Other counties	101,000	152,000

Because of limited wholesale facilities in Daniels and Roosevelt Counties, much of the secondary impact occurs in places such as Glasgow and Glendive, Montana; and Minot, North Dakota.

forty-five minutes. Now, I believe that no one could actually make a statement as to how long a fumigation effect can work.

The problem that I would like to address this panel on is the effects that have been found with some power 274) generating plants, coal-fired generating plants, in North Dakota around the Bismarck area by a practicing veterinarian over there, Dr. Don Hastings, and what happens is that he has concluded and found and in our own little ways of practicing people, farmers and such, we have proven to the fact that when you have an inversion in the air it causes a concentration of the sulfur to be taken up by the alfalfa plant in such a great level that it will interfere with the usage of the--the proper usage of salinium in the body.

Okay. Now, when this happens in--just to digress just a little bit, in a salinium-deficient area we have a problem called the weak-calf syndrome. I don't like that word because it's just a panacea of a big problem, but they have it in certain areas, and we have found out it's a lack of salinium.

Okay. In North Dakota and likewise in our area we are in areas that are known to have adequate supplies of salinium, but these power plants have created what we call necrogenic problem, disease. It's a manmade problem, and what happens with these calves in this Bismarck area is that the salinium was not properly used by the dame, the mother, during

---

Response to Mr. Lee

274) A detailed discussion of the impacts of fumigation is given in Section 5.6.1.3 of the final EIS. The increased trace element concentrations due to fumigation are shown in Table 5.6-2. Selenium is required by livestock at levels between 0.04 and 0.2 ppm. High levels of selenium have been found when soil is amended with 8 percent fly ash (Adriano et al. 1980). The percent increase in the soil due to fumigation is estimated as 0.03 percent. The estimated increase in the aerial plant parts is 0.0007 μg/g dry weight. Selenium deficiency is not expected to be a problem in Montana.

REFERENCES CITED IN RESPONSES TO PUBLIC HEARING

The references listed below were cited in the responses to the letters and Public Hearing only. Other references are listed in the Main Report or the Appendix.

Adriano, O.C., A.L. Page, A.A. Elseewi, A.C. Chang, and I. Straughan, 1980. Utilization and Disposal of Fly Ash and Other Coal Residues in Terrestrial Ecosystems: A Review, J. of Environmental Quality, v.9 no. 3 p. 333-344.

Williams, J.R., 1975. Sediment-Yield Prediction With Universal Equation Using Runoff Energy Factor in Proceedings of Sediment-Yield Workshop, USDA Sedimentation Laboratory, Oxford, Mississippi, November 28-30, 1972. Report No. ARS-S-40 p. 244-252.

Tanji, K.K., 1970. A Computer Analysis on the Leaching of Boron from Stratified Soil Columns, Soil Science 110(1):44-51.

8. LIST OF PREPARERS

Thomas C. Ginn, Ph.D. Dr. Ginn served as project manager for the first phase of the project and was responsible for part of the biological impacts analyses. Dr. Ginn is an aquatic ecologist specializing in the effects of environmental pollutants on the distribution and physiology of freshwater and marine organisms.

Karen V. Summers, M.S. Ms. Summers served as project manager for the second phase of the project and conducted most of the surface water quantity evaluations, water use analyses and part of the water quality impacts. She is an environmental scientist specializing in modeling studies of ground water and rivers, design of field monitoring programs and water quality evaluations.

Stanley W. Zison, Ph.D. Dr. Zison conducted the analyses of baseline water quality. Dr. Zison is an environmental chemist and statistician specializing in waste treatment management and mathematical modeling of the fate of pollutants.

William B. Moreland, M.A. Mr. Moreland was responsible for the air quality modeling and prediction of air quality impacts. He is a meteorological specialist in diffusion analyses, climatological analyses and effects of atmospheric turbulence.

Thomas Grieb, M.A. Mr. Grieb conducted terrestrial biological effects analyses for both air quality and water quantity considerations. Mr. Grieb specializes in the impacts of energy-related operations on biological systems.

J. David Dean, M.S. Mr. Dean conducted parts of the water quality impacts analyses, especially as they realted to agricultural use of water and determined the impacts of boron and salinity on crops. He is an agricultural engineer with experience in the use of stochastic/deterministic models for analyzing water demand by irrigated crops and predicting the fate of pollutants moving through soil.

John W. Ryan, MBA. Mr. Ryan was responsible for partial development of the socioeconomic methodology and impact assessment. He is a specialist in the modeling of complex socioeconomic systems in the public and private sectors.

Daniel T. Dick, Ph.D. Dr. Dick also contributed to the socioeconomic methodology. He is an environmental economist with considerable experience in regional impact analysis of energy development.

Mary E. Gray, B.A. Ms. Gray collected and described information concerning the baseline socioeconomic conditions. She has experience in resource planning, impact assessment and energy development analysis.

Susan Mara, M.A. Ms. Mara is a hydrologist and served as a consultant on water-related matters in the socioeconomic analyses.

Leslie A. Young, M.S. Ms. Young analyzed the direct socioeconomic impacts. She specializes in economic analyses and the development of interview and survey techniques.